COPY NO. 12 OF 150

TECHNICAL MEMORANDUM 1609

LONG RANGE STUDY
OF
PREDICTION OF SAFE LIFE OF PROPELLANTS

NORRIS S. GARMAN
JAMES M. MURPHY

APRIL 1965

AMCMS CODE 4810.16.2153.12

PICATINNY ARSENAL
DOVER, NEW JERSEY

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

DISPOSITION

Destroy this report when it is no longer needed. Do not return.

DDC AVAILABILITY NOTICE

Qualified requesters may obtain copies of this report from DDC.

Picatinny Arsenal Technical Memorandum 1609

LONG RANGE STUDY OF PREDICTION OF SAFE LIFE OF PROPELLANTS

by

Norris S. Garman
James M. Murphy

April 1965

SUBMITTED BY: Earle F. Reese
Earle F. Reese
Chief, Analytical Chemistry Branch

APPROVED BY:
Jean P. Picard
Chief, Propellants Laboratory

Propellants Laboratory
Picatinny Arsenal
Dover, New Jersey

TABLE OF CONTENTS

ABSTRACT

A long range storage program on many of the standard modern propellant formulations is being conducted at Picatinny Arsenal. Propellant samples are conditioned at temperate, tropical, desert, and laboratory controlled accelerated conditions. Standard and experimental testing techniques are employed to determine the safe life potential of each study propellant, and in turn the test methods are being evaluated as to their applicability for establishing stability potential. It has been shown that stabilizer analysis is an effective means for determining the chemical stability of propellants, however, an analytical problem does exist with ethyl centralite. The 65.5°C. Surveillance Test and Propellant Quick Test both appear to be suitable surveillance tools, however, both have short comings. The Methyl Violet Heat Test has limited value for estimating stability potential of an aged propellant, and the Vacuum Stability and Taliani Tests to date have not proven to be particularly beneficial. The Viscosity Test results continue to show promise, and appear to correlate well with the other more reliable testing techniques. A better comprehension of propellant safe life concepts is being realized through the study of the test results of each propellant formulation under study.

OBJECT

To determine: (1) the nature of propellant deterioration under field conditions, and (2) an adequate means of predicting remaining safe life of aged propellant.

SUMMARY

In 1957 a study entitled, "Long Range Study of Prediction of Safe Life of Propellants" was initiated. The program encompasses many of the standard modern propellant formulations under storage at temperate, tropical, desert, and laboratory controlled accelerated conditions. The testing techniques employed represent both standard procedures and newly developed methods which through investigative action show promise. The data shows that the method for analysis of diphenylamine and its primary degradation products is an effective means for determining the chemical stability or safe life potential of propellants. It is felt, however, that the values obtained for ethyl centralite do not demonstrate or fully evaluate the degree of degradation of the propellants and, therefore, the safe life potential is not apparent. The 65.5°C. Surveillance Test of single- and double-base propellants has demonstrated, to date, that the 20 day end-point marking the end of safe life is reliable and affords an ample safety margin for disposition of the deteriorated lot. The Heat Test results, although they do not correlate proportionally with the results of other stability tests, do decrease as the propellant ages and would, therefore, support the findings of

the more reliable tests. The Vacuum Stability and Taliani Tests have not proven to be particularly beneficial, and it appears that only upon approachment of potential hazard does the gassing characteristics increase significantly. The Viscosity Test results continue to show promise, and appear to correlate well with stabilizer and surveillance data. The Quick Test has proven to be a very effective tool for evaluating the condition of stock propellants. Its application is considered to be universal in testing all types of single-, double-, and triple-base propellant formulations. The results of this test have demonstrated that a stage 6 reaction is an effective action point particularly with the single-base propellants. For double- and triple-base propellant, more work is required to establish realistic cut-off criteria.

CONCLUSIONS

It is concluded that the results accumulated on all the study propellant formulations and the understanding of their significance is, for the most part, a product of this program. Continued efforts along this line will aid in evaluating standard methods and developing new test techniques to measure propellant stability potential. It is also felt that furthering the prescribed objectives of this program will lead to a better comprehension of propellant behavior as aging progresses. It is also concluded, that the methods employed in this study are generally applicable to estimate safe life

potential of propellants, but even with great experience in application and interpretation one specific test method should not be relied upon, but rather the entire battery of tests which have shown interpretable results when applied to newly manufactured and aged propellants,for establishing the safe life potential of propellants.

RECOMMENDATIONS

It is recommended that the project be continued along the set lines to the achievement of an understanding of propellant behavior under normal storage; that the reliability of the various stability tests continue to be evaluated; and that investigative work be continued to establish the influences of variables found to exist in the standard and experimental testing techniques. It is also recommended that upon development and standardization of new propellant formulations they too should be incorporated into this program to widen the scope of this study.

INTRODUCTION

In December 1958, a report (Reference 1) was published detailing the steps required for the accomplishment of the objectives of this study. It was therein recommended that the project plan be accepted as sufficiently comprehensive to achieve the planned objectives, and that the program be carried to its completion under OAC Project No. 57-55. This program is summarized in the following paragraphs:

The overall safe-life study encompasses various storage and testing programs. Single-, double-, and triple-base artillery, double-base mortar, and single-base small arms propellant are involved. The conditions of storage were chosen to represent the maximum and optimum natural environmental conditions to which bulk propellant may be subjected. Picatinny Arsenal (PA) surface magazine storage represents temperate conditions, Yuma Proving Ground (YPG) igloo and light cover surface storage (X-Site) represents desert conditions, and Panama Canal Zone (CZ) surface magazine storage represents tropical conditions. It should be noted here that frequent reference is made in all tables presented in Appendix A to these parenthesized abbreviations. In addition, laboratory controlled accelerated aging of small samples was established at Picatinny at 122°, 150° and 176°F., and bulk quantities were stored at Aberdeen Proving Ground (APG) at 122°F.

The total storage temperature range is thus from normal temperature to 176°F. The top-of-the-range is sometimes used in accelerated aging work; but more frequently it is judged to be too far from normal for

dependable prediction of normal storage behavior. This planned varied-condition storage is for the accumulation of data toward the resolution of that age-old problem: the correlation between accelerated aging and normal storage behavior of propellants.

The Description Sheets of each of the propellants involved in these storage actions except for Propellant M15, Lot No. RAD-60387-56 are presented in Appendix C.

In selection of the propellants for this study, ample representation of the presently known troublesome types, M6 and IMR Propellants, was incorporated. The M6 Propellant particularly is represented throughout a wide stability range: from new and stable to aged and of impaired stability. The historical background of each lot of propellant is presented below.

a). The following lots of propellant were of acceptable stability when this program was initiated:

1). BAJ-37579-55 (M6)

2). RAD-60578-54 (M6)

3). IND-39734-56 (M6)

4). RAD-60326-54 (M2)

5). HERC-39649-56 (M9)

6). RAD-60310-54 (M10)

7). RAD-60387-56 (M15)

8). RAD-38145-56 (T28)

b). The following lots of propellant were of impaired stability when this program was initiated:

1). ALA-11225-44 (M6)

2). ALA-31246-44 (M6)

3). ALA-33716-45 (M6)

4). ALA-33746-45 (M6)

5). SUN-19243-45 (M6)

6). SUN-19246-45 (M6)

7). OKLA-29220-45 (IMR)

8). OKLA-29221-45 (IMR)

9). OKLA-29250-45 (IMR)

c). The following lots of propellant have particularly interesting backgrounds and are discussed individually under Discussion of Results:

1). ALA-11225-44

2). IND-BR-39744-56

3). RAD-RB-64012-56

4). PA-E-R-21406-56

The sampling and testing periods were set with respect to the anticipated times required for significant change to take place. Thus, temperate storage samples are taken annually, and tropical and desert sampling are semi-annual. Closer control was exerted over the bulk samples stored at 122°F. at Aberdeen, with inspections and sampling at

about 3-month intervals. Sampling of the small quantities stored at 122°, 150°, and 176°F. varied with type and temperature: from weekly at 176°F. to semi-annually at 122°F.

The following tests and determinations have been used in this study:

Test	Procedure
120°C., 134.5°C. Heat Tests	Technical Report No. FRL-TR-25
90°C. Vacuum Stability Test	Technical Report No. FRL-TR-25
110°C. Taliani Test	Technical Report No. FRL-TR-25
65.5°C. Surveillance Test	Technical Report No. FRL-TR-25
Stabilizer Analysis:	
Diphenylamine	PA Gen Lab Rpt. No. 58-H1-648
Ethyl Centralite	PA Gen Lab Rpt. No. 57-H1-519
Viscosity Test	P.A.T.R. No. 2458 (Modified)
Indicator Paper Test:	
Quick Test	MIL-STD-1231B
N/10 Methyl Violet Paper Test	TB-ORD-657

RESULTS

The progressive data employing the Methyl Violet Heat Test, Vacuum Stability Test, Stabilizer Analysis, and Taliani Test resulting from the periodic testing of propellant samples from the high-temperature storage phase and the natural environmental storage phase are tabulated in Tables I thru XX. In Table XXI there is tabulated the viscosity data of aging propellants after ambient and accelerated storage. Tabulated in Tables

XXII thru XXIV is the Quick Test data of the aging propellants under temperate, tropical, desert and accelerated storage conditions. Table XXV shows the progressive 65.5°C. Surveillance data of the study propellants under temperate, tropical, and desert storage conditions. Table XXVI shows typical surveillance data for IMR Propellants. The tabulation of propellant mass temperature data to the point of spontaneous ignition under desert surface conditions is presented in Table XXVII.

DISCUSSION OF RESULTS

Accelerated Storage Effect on Propellant:

In Reference 2, the results of the first year of storage at elevated temperature are presented. Although the total storage time then was relatively short, the data was sufficient to show that the Available Stabilizer Content determination was overall uniform in showing the gradual dissipation of stabilizer during elevated temperature storage. Similar uniformity in depicting advance in deterioration was not shown by the data from Heat Test or Vacuum Stability Test. With these tests, the generally accepted theory is that the indicator paper bleaching time decreases and the gassing potential increases with the advance of deterioration. However, the test results on propellants, subsequent to elevated temperature storage, produced exceptions to this theory. Thus, in each test dependent upon the evolution of gases of decomposition, (Heat Test, Vacuum Stability Test and Taliani Test), the gassing potential

was shown to have been lost during the initial accelerated storage period. It was concluded at that time that a trend toward cook-off of deterioration products from propellants under high temperature accelerated aging was definitely indicated; that cook-off strongly influenced those standard stability tests which measure gassing characteristics, even to the point of rendering them invalid; and that cook-off constitutes a condition proportionally unrelated to normal aging. Since that time, with the continued storage and testing, the data shows that these conclusions were valid. Even at the lowest accelerated temperature (122°F), the gassing characteristics of the propellants degressed showing definite evidence of cook-off. Of the tests employed, the Stabilizer Analysis and Viscosity Test were the only methods which were used successfully to follow the deterioration of a propellant formulation under accelerated storage conditions. In review of the data presented in the tables relative to those propellants stored at 122°, 150° and 176°F., it is apparent that the influence of accelerated storage is not evident from those tests measuring gassing potential. Generally, the Heat Test values are higher than the initial, and the Vacuum Stability Test values are lower showing that the gaseous decomposition products have been dissipated through storage. The periodic viscosity data shows that the long chain structure of the nitrocellulose is being affected in all the propellant formulations, and particularly the T28 and M15 compositions as shown in Table XXI. The stabilizer data shows that the

higher the storage temperature the more rapid the stabilizer is dissipated. This, of course, is as would be expected. In Figures I, II and III (Appendix B),there is graphically depicted the depletion rate of diphenylamine content of three lots of propellant stored under the various high temperature and ambient conditions. Lot ALA-11225 was an impaired M6 Propellant approximately half stabilized initially; lot RAD-60578 and RAD-60310 were essentially newly manufactured M6 and M10 propellants respectively. Each shows that the rate of stabilizer depletion is dependent upon the storage temperature. This data also demonstrated the usefulness of the diphenylamine determination of available stabilizer in following the deterioration rate of propellant formulations employing this stabilizer. It should be noted, however, that the analytical data did vary, and that these curves were drawn to fit the majority of the points plotted.

Stabilizer Analysis:

In the initial year of this program a report was published (Reference 3) describing a spectrophotometric method of analysis of actual diphenylamine (DPA) and its primary degradation products, N-nitroso-diphenylamine (N-NO-DPA) and 2-nitrodiphenylamine (2-NO_2-DPA). With analysis of synthetic mixtures of the above ingredients, the method appeared to be quite applicable to follow analytically the degradation rate of DPA stabilized propellants. This procedure was, therefore, applied to the initial and subsequent samples connected with the study of the prediction of safe life of propellants. It was later discovered

that the nitrocellulose, nitroglycerin, and dinitrotoluene ingredient in propellants greatly enhanced the conversion of the N-NO-DPA to DPA during the alkali steam distillation separation. This of course illustrated that the data for DPA and N-NO-DPA available was erroneous. The separation procedure was altered to eliminate the alkali interaction, and therefore, improve the accuracy of the analysis. The improved method, as described in Reference 4 was applied to the safe life samples in September 1958, and the effect of this method change is apparent in the data presented in all the tables for DPA stabilized propellants.

Concurrent with the DPA method development, a method for analysis of actual ethyl centralite (EC) and its primary degradation products, N-nitroso-N-ethylaniline (PEN) and 2-nitro-N-ethylaniline (2-NEA) was developed and reported in Reference 5. The analysis of synthetic mixtures of the above ingredients was not conducted due to the unavailability of the degradation products. It is felt that the data presented in the tables for EC stabilized propellants does not demonstrate or fully evalute the degree of degradation, and therefore, the safe life potential is not apparent. It is felt that further investigative work should be conducted on this method to fully verify the accuracy and dependability of the results.

In review of the DPA stabilizer data, it is felt that these results can be used for estimating safe life potential of the propellant. It is also felt that the actual DPA or total available stabilizer contents are of more significance than are the degradation products alone.

The objectives of future work will be to establish a deterioration rate curve typical for each propellant formulation, thereby establishing the cut-off point indicating end of safe life for each individual formulation.

65.5°C. Surveillance Test:

The 65.5°C. Surveillance Test is made upon a sample of 45 grams, a weight much more representative of a propellant lot than that which is used in the shorter stability tests. This sample is placed in an 8-ounce, wide mouth, colorless bottle, the top of which is ground glass in order to make an essentially airtight seal. The test sample, so prepared and sealed, is placed in heat. Examination of the test in progress is made daily, and samples which show the red fumes of nitrogen dioxide are withdrawn. The number of days to the appearance of red fumes is computed and this comprises the test result. It is a requirement, as stipulated in most all current propellant specifications, that a five pound representative sample of every lot of propellant for all type weapons be forwarded to Picatinny Arsenal for the purpose of conducting the 65.5°C. Surveillance Test. It is then the responsibility of this Arsenal to furnish Ammunition Procurement and Supply Agency with the stability status of all propellants in the system. The criteria for establishing a lot of propellant, regardless of formulation, unsafe for further storage is for the sample under test at 65.5°C. to produce red fumes in 20 days or less. Since the master sample may not necessarily represent the condition of the lot of propellant stored in bulk quantities in the field, it is recommended upon each failure, that

if the quantity of propellant remaining in stock justifies consideration, a resample be taken and forwarded to Picatinny for complete laboratory analysis.

It should be pointed out here, that triple-base propellants and also some double-base propellants, such as T28 composition containing a high ethyl centralite concentration, do not give effective end-points under these testing conditions, since only very rarely do they produce red fumes. Fumes do, however, appear upon opening the bottle after approximately 1000 days. A noticeable characteristic of the propellant grain, after long storage, is the color change of the unglazed triple-base formulations and also the loss of physical integrity.

Of the modern propellant formulations, the IMR composition has proven to be the most prone to deterioration. The surveillance data presented in Table XXVI is typical of the deterioration pattern of the IMR Propellant. It is of particular interest here to note the sharp decrease in days to red fumes after approximately 10 years of storage, and the relatively short time thereafter that failure occurs. We do not know if this sharp decrease is typical only of this formulation, or whether upon advance deterioration of other propellants, a similar reaction will occur.

There have been incidents, again with IMR Propellant, to support the 20 day failure criteria for establishing the end of safe storage life of propellants. It is the policy to reserve a small quantity of the master sample after a failure has been recorded for exploratory purposes.

These samples are stored in a magazine under ambient conditions. It has been observed, in some cases, that fumes begin to appear in these samples some 3 to 4 years after the date of surveillance failure. In addition, in this program boxes of a propellant lot are segregated in an isolated area after the field and laboratory tests indicate the approach of storage hazard. This propellant mass is allowed to continue to degradate to the point of spontaneous ignition. In October 1962, a study lot of IMR Propellant at Yuma Proving Ground under igloo storage showed low Heat Test values, high gassing characteristics, total stabilizer content of 0.07%, a red fume time of 5 days, and a Quick Test value of stage 6+; every indication of advanced deterioration. In July 1963, after nine months exposure to desert climatic conditions approaching 130°F., the propellant mass did spontaneously ignite and burn. This action is, of course, somewhat more extreme than could ever be expected under igloo storage conditions, since desert surface temperatures often exceed 150°F. during the Summer months. The point is that the Surveillance Test data in conjunction with the other laboratory tests did predict the storage hazard with a sufficient safety margin for disposition action.

There are, however, other incidents which do somewhat cloud the picture. In 1955, only two years after manufacture, a double-base M2 Propellant stabilized with ethyl centralite broke down under master sample storage to the extent that it would produce fumes in 17 days under 65.5°C. Surveillance conditions (200 days is normal) and fired in 4 days

at 80°C. Analysis of the sample at this stage of behavior revealed the ethyl centralite content to be 0.61% or essentially that which was originally incorporated. It is also interesting to note the results of the single-base propellant lot number ALA-11225 which has had a history of poor safe life potential since the initiation of this program. The laboratory test results are presented in Table I and show, among other things, that the propellant retains no actual diphenylamine, and only 25% of the total stabilizing potential remains in the form of primary degradation products of diphenylamine. The propellant, however, continues to withstand approximately 1300 days of conditioning at 65.5°C. before red fumes appear as is shown in Table XXV. This constitutes a loss of only 500 days from that which is considered normal for this particular formulation compared to a loss of 75% of its stabilizing potential. This suggests that the general 20 days fume time established for the safe storage life may not be applicable to all single- and double-base formulations.

Normal Methyl Violet Heat Test:

The Normal Methyl Violet Heat Test is a long standing stability test, the end-points of which are based upon the gassing characteristics and temperature resistance of the propellant. The test is conducted at two different temperatures depending upon the composition of the propellant. Single-base propellants are tested at 134.5°C., while double- and triple-base propellants are tested at 120°C. Three distinctive end-points are associated with this test, the time required

to bleach the indicator paper to a salmon pink color, the time required for the propellant to produce red fumes of nitrogen dioxide, and whether or not the propellant explodes in 5 hours or less. The Heat Test, being a short term test, has for many years been used as a control on manufacture, but now the question arises as to the applicability of the test to estimate the safe life potential of aging propellants. Some years ago, a problem was under consideration as to the acceptance criteria for the selection of partly deteriorated M6 Propellant for reblending in an effort to revitalize some of the aging stock. A decision was made at that time to reblend those lots showing 0.50% (half of original) available diphenylamine, but not showing Class 2 or 3 reaction in 30 days in the N/10 Methyl Violet Paper Test. The Heat Test was at that time considered unreliable, since there was no correlation between values obtained and diphenylamine contents on 80 lots tested. A review of this data shows while the available diphenylamine content varied between 0.77 and 0.08%, the Heat Test salmon pink values were quite consistent at 30 to 35 minutes or 20 to 25 minutes below the original acceptance values. In this case, and in this study, it is evident that the salmon pink value does decrease upon aging, but not proportionally with the stabilizer content. Only at the point of potential hazard does it show values in the 5 to 10 minute range and after which the propellant does explode in less than the 5 hours. It has also been observed, and is noted in most all the tables, that a large variation of values exist from test period to test period. It is

not sure whether this variation is caused by ppor sample representation of the lot being evaluated, or whether this is inherent in the testing procedure.

Propellant Quick Test:

It has been long recognized that the master samples of propellants retained at Picatinny may not reflect the stability of the same lots stored in the field. To effect field control of stored propellants, the N/10 Methyl Violet Paper Test was devised and has been in use for many years. The test paper is inserted under the lid of boxed propellant and observed in most cases annually. On production of a Class 3 reaction on the Methyl Violet paper, which is the most advanced stage where the paper is bleached white after 30 days exposure to the propellant, action is taken to have the stability of the propellant established by laboratory tests. Through these laboratory tests it was found that for many of the more modern double- and triple-base propellants, a Class 3 reaction occurred while the propellant itself had not appreciably deteriorated. It was, therefore, indicated that a new test was needed to ascertain the stability potential of these propellants in bulk storage. The Quick Test was developed and has been actively evaluated by the ammunition inspectors at all installations involved in bulk storage of propellant. On the basis of the results of tests on approximately 3000 lots involving 24 propellant formulations, the Quick Test procedure was accepted and established as a standard along with the N/10 Methyl Violet Paper Test.

In the Quick Test, a stage 6 reaction has been shown to be an effective action point. With the single-base propellants it reflects an 80% reduction in actual diphenylamine content. Such propellant is unserviceable for stock pile loading, and continued storage would present an ever increasing hazard. With double- and triple-base propellants, stage 1 to 3 reactions are yielded by acceptably stable materials; consequently a stage 6 reaction will (1) occur before a hazardous condition exists, and (2) signal a likely point for investigative action required for establishing a cut-off criterion for these propellant types.

Within the experiences gained in this program, extremely advanced Quick Test reactions have been discovered in the testing of imminently hazardous propellant. A stage 8 reaction is produced, accompanied by a yellowing of the diphenylamine-impregnated dry portion of the indicator paper. This reaction is recognized as being the ultimate endpoint of the Quick Test. That it coincides with the condition of extreme deterioration of the propellant is of particular significance.

Propellant Viscosity Test:

In looking toward new concepts of stability testing, the Viscosity Test appears most promising. The propellants tested appear to conform to the accepted theory that heat and age cause a rupture of the $O\text{-}NO_2$ bond (or propellant deterioration), and also causes a reduction in the degree of polymerization of the nitrocellulose, and therefore, the viscosity of the propellant in solution. In viscosity work, it cannot be assumed that nitrocellulose from different lots and from different

manufacturers have the same initial viscosity. Hence, any relationship between propellant deterioration and viscosity must be based on two or more measurements. In the absence of knowledge of the propellant viscosity at the time of manufacture, the viscosity value for any particular lot of aging propellant is of no quantitative significance. In the exploratory work, the two-point system was achieved by determining the viscosity of the study propellants before and after accelerated aging for 2 days at 80°C. Some typical results of these tests and the test results from the periodic sampling of the propellants stored under ambient conditions at Picatinny Arsenal and Panama Canal Zone are presented in Table XXI. It is of interest to note the trends reflected as follows:

a). The effect of adverse normal storage is reflected by lower viscosity values when compared with samples subjected to temperate climatic conditions.

b). Double- and triple-base propellants stabilized with ethyl centralite are more susceptible to viscosity reduction than single-base diphenylamine-stabilized propellants.

c). The viscosity behavior of acceptable and impaired M6 Propellant was found to differ in that acceptable propellant showed a reduction in viscosity to a lesser degree than the impaired propellant.

The Viscosity work conducted on those propellants conditioned at high temperature demonstrates the degree of deterioration of the nitrocellulose that can be expected before fumes of nitrogen dioxide are

are observed. Generally, double-base propellants cannot withstand aggravated storage for long periods of time. The viscosity work did not coincide with the initiation of the high temperature storage phase, and therefore, viscosity data presented in Table XXI for lots RAD-60326 (M2 Propellant) and HERC-39649 (M9 Propellant) was not obtained before the samples were destroyed after fuming at 65.5°C. However, T28 Propellant stabilized with 6.00% ethyl centralite did not fume after 30 months at 65.5°C., and 81 months at 50°C. This formulation has a history of not producing red fumes after long periods of storage at aggravated conditions, and yet by observing the viscosity data it can be seen that the nitrocellulose is completely deteriorated. In conjunction with the nitrocellulose breakdown after lengthy storage at extreme conditions, a complete loss of physical integrity has been observed to the point where the grain becomes malleable by hand pressure. The triple-base propellants, as has been previously noted, do not fume at high temperature conditioning, but by noting the viscosity data for lot RAD-60387 it can be seen that the nitrocellulose is nevertheless degrading. With this formulation also, the physical strength is lost after long periods of high temperature storage.

Propellant Gassing Characteristics:

The Vacuum Stability and Taliani Tests are dependent upon the gassing characteristics and heat resistance of the propellant. There are stipulated, in some detailed specifications, requirements for the

Vacuum Stability Test. These are, of course, primarily to control manufacture. In the evaluation of these tests for establishing criteria for safe life potential, the results have not proven particularly beneficial. It appears that only upon approachment of potential hazard does the gassing characteristics increase significantly. During the progressive testing of the propellants sampled periodically from the various storage areas, it is apparent that the test values vary widely. These values also appear to have little correlation with the other stability test data.

Stability Behavior of M6 Propellant:

Some of the propellant lots involved in this program have particularly interesting histories. In the following paragraphs each of these lots are discussed individually noting their backgrounds and stability behavior:

Propellant M6, Lot No. ALA-11225-44, being 13 years old at the time this program was initiated was of impaired stability. Generally the laboratory test results of this propellant has reflected that the extremity of the climatic storage condition has not been a determining factor on the degradation rate in that the results from temperate, tropical, and desert storage areas are quite similar. It is of particular interest, however, to note the reaction of this lot to extreme temperature variation during ambient storage. Under the desert surface storage, in which the bulk propellant is stored in a shaded area but exposed to other climatic conditions, the propellant produced a

considerable quantity of moisture. The propellant mass was completely wetted, and the atmosphere within the storage container contained a high percentage of moisture. Thus, obtaining reliable Quick Test results was not possible because the moisture wetted the test paper and faded the end-point. This type reaction was also apparent at Aberdeen Proving Ground upon the transfer of the propellant from ambient storage to storage at 122°F. The same propellant, however, stored under desert igloo, temperate, and tropical conditions showed no tendency to produce moisture. This leads to the conclusion that the high degree of temperature fluctuation experienced under the two storage conditions noted is the factor which develops the tendency for this single-base propellant formulation to produce moisture.

During the 1955-56 era there were large stocks of single-base propellant which showed doubtful stability characteristics. In an effort to determine whether or not a partially deteriorated propellant could be reworked into an acceptable propellant, Radford Arsenal Production Data No. 4000 was established, and a reblending operation commenced. The specific requirements for each individual lot were as follows: the available DPA content shall be a minimum of 0.50% or the arithmetical average of the DPA and total available stabilizer content shall be a minimum of 0.50% provided that the DPA is a minimum of 0.40%. The lot must also not produce Class 2 or 3 papers in 30 days in the N/10 Methyl Violet Paper Test. Representative of these reblended lots are

IND-BR-39744-56 and RAD-RB-64012-56. It should be noted, however, that the candidate lots used for the RAD reblend meet only the minimum stabilizer requirements. In conjunction with this effort, Picatinny Arsenal reworked a small quantity of propellant from the same series of propellant lots from which RAD-RB-64012-56 was reblended. These lots exhibited signs of deterioration in storage paper tests, gave a 35-minute Heat Test (134.5°C.), and had an available diphenylamine content of less than 0.50%. As part of the rework, make-up ingredients (dinitrotoluene and diphenylamine) based on a chemical analysis of the ground material, were added to the mix in sufficient quantities in order to conform with specification requirements. This material, identified as Lot PA-E-R-21406-56 was manufactured to completion, and the weight of the finished propellant was 2,690 pounds.

All three of these propellants have been stored at both surface and igloo desert conditions, and at 122°F. at Aberdeen Proving Ground. The IND reblend lot initially showed 0.79% diphenylamine and a total stabilizer content of 0.96% as shown in Table X. The degradation rate through the six years desert storage is essentially the same as the newly manufactured propellant Lot No. IND-39734-56 with a total stabilizer content of 1.09% as shown in Table IX. This indicates that the reblending effort accomplished through Radford Arsenal Production Data No. 4000 has been successful in producing a propellant with a high stability potential. The RAD reblend with the lower initial stabilizer

content has deteriorated at a slower rate under these storage conditions as shown by the data presented in Table XI. This is not particularly unusual since it has become apparent as a result of this study that as a propellant ages the degradation rate decreases as indicated by the total stabilizer analysis. Whether this decrease of deterioration rate is due to the seasoning of the formulation and the formation of the primary degradation products of the diphenylamine, is not certain, but in reviewing the stabilizer data for the reworked propellant in Table XII for lot PA-E-R-21406-56, this thinking is supported. Initially this lot showed an unusually high concentration of degradation products of diphenylamine constituting the major portion of the stability potential. The degradation rate under the desert climatic condition was not to the degree of either the new propellant IND-39734 or the reblend propellant IND-BR-39744. The reason for the high percentage of degradation products in this lot is no doubt due to the fact that during the reworking these products were not extracted from the formulation. Only upon further aging and study will the benefits of this technique be realized.

Temperature Progression Associated with Propellant Deterioration:

In 1956, IMR Propellant Lot No. ALA-4603-42 failed the 65.5°C. Surveillance Test by producing red fumes in less than 20 days. There were remaining at Pueblo Army Depot some few boxes of this propellant in bulk storage. These boxes, along with other boxes of deteriorated IMR Propellant Lot Nos. OKLA-20959-42 and OKLA-20966-42, were placed in open storage under the semi-desert conditions at Pueblo, and efforts were made to monitor the propellant mass to ascertain the temperature progression associated with rapid deterioration leading to spontaneous ignition. In August 1962, six years after surveillance failure, one box of the ALA-4603 lot did spontaneously ignite and burn. Unfortunately instrumentation failure occurred and no useful data was obtained. It is known however that ignition occurred in a 24 hour period after the first temperature rise above that of ambient was noted. The remaining boxes continue to be monitored during each Summer season. The condition of the propellant grew progressively worse during those six years of storage as indicated by the Quick Test. These tests

showed a stage 8 reaction within a 5 minutes test time with a deep yellow coloration of the dry portion of the test paper. The acrid odor of nitrogen oxides were prevalent each time the container was opened. The physical appearance of the propellant grain was however, unchanged.

Temperature data was, however, obtained at Yuma Proving Ground as was previously described in page 15. Reference is made to Table XIII which presents the progressive laboratory data for IMR Propellant Lot No. OKLA-29220 prior to and including the 63 months storage at the desert surface and igloo storage. At that time, the laboratory and field test results of both boxes G-3-I and G-3-X indicated that further storage was undesirable since deterioration had proceeded to the point of hazard. The test results also indicated that the igloo storage with its continuous high temperature, as represented by box G-3-I, appeared to be more detrimetnal to the propellant than the day-night fluctuations occurring in the shaded surface area as represented by box G-3-X. The mass temperature data obtained on both containers exposed to the desert surface conditions is presented in

Table XXVII. In review of the temperature data one month prior to this time, it was noticed that the temperature in both containers were fluctuating along with the ambient temperature. Shortly thereafter, however, the temperature in Box G-3-I began to level off as if insulated from the effect of exterior conditions, whereas Box G-3-X continued to fluctuate. Fifteen hours prior to the ignition of Box G-3-I the temperature break occurred at which time the temperature increased at a rate of 2°F. per hour. The final temperature record was 156°F., some 50°F. above the temperature recorded in Box G-3-X. The propellant then proceeded to spontaneous ignition within a half hour period. For the following month, Box G-3-X continued to fluctuate showing the influence of outside conditions, but then the temperature in it too began to level off. However, the intense Summer heat was subsiding and ignition did not occur until some 11 months later during the heat of June. It is not as yet known the reason for the insulating effect and whether a similar condition will occur with other deteriorating propellant formulations. It is felt however, that it is the result of the exothermic reaction occurring in the propellant during rapid deterioration that maintains the temperature, and it is also reasonable to believe that this reaction will occur in other propellant formulations.

Surveillance Activities:

As was previously discussed in the paragraphs pertaining to the 65.5°C. Surveillance Test, propellant master samples representing each lot made for the Army are forwarded to Picatinny Arsenal by the manufacturer. However, just after World War II the number of samples processed exceeded the capacity of the facilities at this Arsenal. Therefore, attempts were made to alter the normal surveillance schedule to effect economy without either a significant loss of technical information or an appreciable deviation from the safety function of surveillance testing. Initially, the authorized discontinuation of some master samples and the suspended testing of new samples giving values of 365+ days made it possible to carry on the project with the existing facilities. Nevertheless, the high rate of receipt of new samples made it necessary to further reduce the inventory. In February 1949, authorization was granted for the discontinuation of 90 percent of those master samples representative of powder lots over five years old and loaded entirely in case ammunition of caliber less than 3-inch. In making the choice of the 10 percent of master samples to be retained, the first sample of each series received from each manufacturing facility, of each caliber, was selected and each tenth sample thereafter. It is considered that by this means a satisfactory core of reference samples is maintained. This practice was continued until March 1961 and afforded the opportunity to test all samples on a continuous basis.

Propellant Safe Life Predictions:

One of the primary objectives of this project is to correlate the resulting test data to ascertain the safe life of the propellant formulations under study. The following observations are the initial effort to satisfy this objective.

In considering the caliber .30 and .50 IMR Propellant, much has been previously stated as to the stability weakness inherent in this formulation. In 1950, there was recorded the first failure of this formulation under the 65.5°C. Surveillance Test. The lot involved was manufactured in 1944 and was, therefore, at that time 6 years old. Progressively through the years to the present, the IMR Propellant has produced failing data. Since much stability test data is available on those propellant lots that have deteriorated to the hazard point much more confidence is felt in establishing safe life predictions than with the other formulations where the threshold values of stabilizer, heat resistance, gassing characteristics, and viscosities with respect to stability hazard of the propellant are not exactly known.

In studying the Surveillance Test history for a group of caliber .30 and .50 IMR Propellants manufactured by various producers from 1940 through 1945, we find there were a total of 980 lots maintained in the inventory. Of this number 281 failures (red fumes produced in 20 days or less) were recorded or 28.7 percent of the total. One hundred and eighteen samples of the current stock (699 samples) have reached the surveillance breaking point, defined as that point where the time to red

fumes is approximately 20 percent of the initial acceptable value (500 days). It has been established, considering this study as a whole, that this point occurs on an average of 1.6 years prior to failure, however, when age is considered it is known that those lots less than 15 years old will have their breaking point 1.1 years before failure and lots more than 15 years old the point will occur 2.4 years before failure. Therefore, in considering the remainder of this study group, it can be expected that another 16.9 percent will fail in the next 2.4 years bringing the total percent failure to 45.6 for IMR Propellant approaching a maximum age of 25 years.

At the time when the failure rate of IMR was beginning to become excessive, a chemical, stability, and microscopic investigation was initiated (Reference 6) in an effort to determine the causes and possible mechanisms of decomposition. Some of the results of this study are as follows:

The IMR Propellant is a nitrocellulose base-grain, coated with dinitrotoluene. It has been generally established that the coating has a sealing effect, tending to bottle up decomposition products within the grain. Thereby, autocatalysis is quickened. Also, the outward showing of the inward deterioration is deterred. Those tests which depend upon the evolution of gas from the whole grain are thus affected; these will depend upon the point of rupture of the seal. We must assume that at normal storage temperatures, the deterioration will advance to such a point that disintergration of the seal will occur.

If the physical and chemical characteristics of the DNT were always the same, if the thickness of the coating was always the same, and if the application of the coating was invariable, we could expect the rupture (or disintergration) of the seal to occur always at a certain stage of deterioration of the base-grain. However, these variations can not be avoided in the actual manufacture of the propellant since the necessary process controls are not part of the specification procedure. Thus we recognize certain variables which influence the behavior of this propellant under normal storage. Conceivably, therefore, a coated and an uncoated propellant having essentially similar storage histories would behave differently under the 65.5°C. Surveillance Test. The uncoated propellant would undergo a gradual deterioration, indicated in its progressive testing by the slow decrease in the number of days to red fumes under this test. This behavior has been shown by M6 Propellant. The coated propellant (IMR), because of the seal-like characteristic of the coating shows no change in the 65.5°C. Surveillance Test for a long period of time; but suddenly a spectacular drop in the number of days to red fumes results from the sudden rupture of the coating allowing the gaseous decomposition products to give a positive test of instability by the Surveillance Test. This phenomonon is quite evident in the data presented in Table XXVI. It was also stated that the microscopic study of IMR Propellant in various stages of deterioration showed that a propellant grain, indicative of the propellant as a whole, undergoes various color changes

during its deterioration. A relatively new propellant will have grains that are practically white, with possibly a faint tinge of green around the periphery of the grain. On the other hand a completely unstable propellant will have grains that are colored deep orange and contain crystalline material dispersed throughout its interior. It was also found that the color of the grains ranged from almost white to yellow-orange in the interior of the grains with the interior mass bounded by greenish bands. The source of these colors must necessarily come from the various nitrated products of diphenylamine formed as a result of a reaction between the diphenylamine and the decomposition products of nitrocellulose.

It is known that a propellant containing incorporated dinitrotoluene (M1 and M6) has a high 65.5°C. surveillance life, yielding normal values of 1800 days. Nitrocellulose propellant (M10) and dinitrotoluene-coated nitrocellulose propellant (IMR) both yield lower surveillance values around 500 days. Therefore, if part of the grain of IMR Propellant is a mixture of nitrocellulose-dinitrotoluene, then it is conceivable for that region to be more stable than the remainder of the grain, which contains only nitrocellulose. Stabilizer is considered uniform through the grain. This physical distribution of dinitrotoluene is highly possible in the IMR Propellant grains. The green colored area could be indicative of the depth of dinitrotoluene penetration, since the green colored areas are approximately 10-15% of the grain. If this is the physical characteristic of the

IMR Propellant, then it can be concluded that the decomposition of nitrocellulose in the interior of the grain would be more rapid than in the green colored areas. This would eventually result in a high concentration of gaseous decomposition products in the interior of the grain which would eventually cause the rupture of the coating.

New coating materials are currently being investigated for small arms propellant. Their effect upon the stability potential of the propellant will be of prime interest. It is hoped that their use as a deterrent for the propellant will also increase their safe life potential over that of IMR.

Because of the wide safe life range that has been found for the IMR Propellant (6 to 25 years) by the 65.5°C. Surveillance Test, it is somewhat difficult to establish a safe storage limit for this formulation. However, with due consideration of the failure recorded in the 65.5°C. Surveillance Test, and the available stabilizer content of the propellants that have reached this point after 15 years of storage, 15 years has been established as the average safe storage life for IMR Propellant for .30 and .50 caliber ammunition.

The estimated safe life of other propellant formulations is based primarily upon the experience and storage histories since the time they were established as standard Army Artillery Propellants and subsequently manufactured in bulk quantities. Therefore, the storage times established as follows do not necessarily indicate that the

propellants are not safe after the indicated number of years, but show the time for which each formulation has been in existence without any indication of storage hazard.

Propellant Formulation	Stabilizer	Safe Life, years
M1	DPA	40
M2	DPA	25
M2	EC	20
M5	DPA	25
M5	EC	20
M6	DPA	35
M8	DPA	25
M8	EC	20
M9	DPA	25
M9	EC	20
M10	DPA	20
M15	EC	15
M17	EC	15
M26	EC	10

REFERENCES

1. Technical Memorandum No. GL-4-58, "Investigation of the Stability of Deteriorating Propellants", Norman E. Beach, December 1958.

2. Technical Memorandum No. GL-1-59, "Long Range Study of Prediction of Safe Life of Propellants", Norman E. Beach and Norris S. Garman, January 1959.

3. Picatinny Arsenal Technical Report No. 2407, "Spectrophotometric Method for the Simultaneous Determination of Actual Diphenylamine and Its Primary Degradation Products in a Propellant", M. A. Laccetti and M. Roth, April 1957.

4. Picatinny Arsenal General Laboratory Section Report No. 58-Hl-648, "Improvement of the Spectrophotometric Method for Analysis of Diphenylamine and Its Primary Degradation Products", M. A. Laccetti and M. R. Younginer, June 1958.

5. Picatinny Arsenal General Laboratory Section Report No. 57-Hl-519, "Spectrophotometric Method for the Simultaneous Determination of Actual EC and Its Primary Degradation Products in Propellants", M. A. Laccetti, M. R. Younginer and M. Roth, March 1957.

6. Picatinny Arsenal General Laboratory Report No. 56-Hl-1933, "Instability of Some IMR Propellant Lots", C. Ribaudo, R. Atno, N. Gelber, G. Albansoder, J. Kapash and S. Lader, November 1956.

APPENDIX A

TABLES I THROUGH XXVII

TABLE I

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. ALA-11225-44

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	35	6.80	40	0.28	0.01	0.16	0.45			
176	1	50	1.91	40	0.18	0.00	0.11	0.29			
176	2	50	1.89	40	0.17	0.00	0.10	0.27			
176	2.5				0.12	0.02	0.08	0.22			
150	6	45	1.39	40	0.12	0.00	0.05	0.17			
150	12	55	2.57	40	0.03	0.00	0.04	0.07	----	---	0.20
150	18	50	2.92	40	0.02	0.00	0.03	0.05	----	---	0.25
150	24	45	3.52	40	0.04	0.00	0.03	0.07	----	222	0.40
150	30	55	1.31	40	0.00	0.02	0.05	0.07	----	---	0.15
150	36	40	1.83	40	0.10	0.03	0.03	0.16	0.40	222	0.40
122	6	25	4.91	40	0.21	0.01	0.16	0.38			
122	12	45	2.78	40	0.00	0.11	0.12	0.23	0.53	194	0.55
122	18	35	1.83	40	0.00	0.09	0.14	0.23	----	235	0.45
122	24	50	2.33	40	0.04	0.02	0.08	0.14	0.55	112	0.65
122	30	50	1.29	40	0.00	0.05	0.11	0.16	----	---	0.15
122	36	40	1.77	40	0.03	0.01	0.08	0.12	0.40	212	0.40
122	52	40	1.55	40	0.01	0.01	0.05	0.07	0.50	226	0.30
122	66	50	1.27	40	0.00	0.02	0.03	0.08	----	---	0.15
122	81	45	1.57	40	0.02	0.02	0.03	0.07	0.55	144	0.55
Initial	0	35	6.80	40	0.28	0.01	0.16	0.45			
PA Ambient	12	25	5.96	40	0.25	0.05	0.18	0.48			
PA Ambient	24	40	1.12	40	0.11	0.05	0.18	0.34	1.02	69	1.00
PA Ambient	36	40	4.66	40	0.09	0.06	0.14	0.29	0.94	80	0.80
PA Ambient	48	50	4.41	40	0.12	0.04	0.18	0.34	0.74	93	0.68
PA Ambient	81	45	3.55	40	0.01	0.19	0.15	0.35	1.22	56	1.00
CZ Ambient	6	30	4.46	40	0.23	0.01	0.17	0.41			
CZ Ambient	12	35	4.66	40	0.20	0.02	0.17	0.39	0.78	106	0.80
CZ Ambient	18	30	6.51	40	0.00	0.14	0.19	0.33	1.45	31	----
CZ Ambient	24	40	2.25	40	0.05	0.10	0.19	0.34	1.00	72	0.85
CZ Ambient	30	35	3.65	40	0.00	0.16	0.18	0.34	0.71	90	0.70
CZ Ambient	36	35	4.68	40	0.00	0.12	0.16	0.28	0.69	127	0.80
CZ Ambient	42	35	3.80	40	0.12	0.13	0.20	0.45	0.71	155	1.05
CZ Ambient	52	35	4.31	40	0.02	0.14	0.14	0.30			
CZ Ambient	57	45	4.20	40	0.00	0.16	0.18	0.34	0.57	106	0.50
CZ Ambient	64	40	3.82	40	0.06	0.13	0.06	0.25	1.17	56	0.90
CZ Ambient	70	30	3.49	40	0.01	0.14	0.16	0.31	0.98	82	0.95
CZ Ambient	79	40	2.66	40	0.02	0.13	0.15	0.30	1.85	38	----
CZ Ambient	85	35	3.45	40	0.05	0.11	0.16	0.32	0.98	75	0.85

TABLE I (Cont)

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. ALA-11225-44

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	35	6.80	40	0.28	0.01	0.16	0.45			
YPG X-Site	6	35	4.37	40							
YPG Igloo	6	35	4.30	40							
YPG X-Site	12	35	4.83	40	0.03	0.18	0.15	0.36			
YPG Igloo	12	30	4.82	40	0.01	0.18	0.16	0.35			
YPG X-Site	22	40	5.89	40	0.00	0.21	0.19	0.40			
YPG Igloo	22	45	5.87	40	0.00	0.16	0.18	0.34			
YPG X-Site	30	40	4.29	40							
YPG Igloo	30	45	2.61	40							
YPG X-Site	34	45	4.33	40	0.00	0.23	0.14	0.37			
YPG Igloo	34	45	4.94	40	0.00	0.24	0.14	0.38			
YPG X-Site	39	45	2.72	40	0.00	0.18	0.17	0.35			
YPG Igloo	39	40	2.40	40	0.00	0.22	0.18	0.40			
YPG X-Site	45	35	3.30	40	0.00	0.16	0.14	0.30	0.74	104	0.65
YPG Igloo	45	35	4.21	40	0.04	0.14	0.15	0.33	0.53	163	0.60
YPG X-Site	51	45	4.00	40	0.01	0.16	0.16	0.33	0.65	120	0.70
YPG Igloo	51	45	4.34	40	0.00	0.19	0.15	0.34	0.65	132	0.60
YPG X-Site	63	35	3.73	40	0.04	0.14	0.16	0.34	0.69	102	0.55
YPG Igloo	63	35	3.82	40	0.07	0.15	0.16	0.38	1.31	56	0.90
YPG X-Site	69	40	3.60	40	0.00	0.17	0.16	0.33	0.65	114	0.70
YPG Igloo	69	30	4.49	40	0.00	0.20	0.18	0.38	0.82	90	0.75
YPG X-Site	75	35	4.89	40	0.02	0.16	0.13	0.31	1.25	50	0.85
YPG-Igloo	75	35	5.72	40	0.04	0.16	0.14	0.34	1.75	40	-- -
YPG X-Site	81	45	2.71	40	0.00	0.14	0.16	0.30	1.17	56	0.60
YPG Igloo	81	45	2.97	40	0.00	0.18	0.16	0.34	1.64	48	---
APG @ 122°F.	2	25	5.30	40	0.19	0.03	0.17	0.39			
APG @ 122°F	6	30	4.67	40	0.00	0.28	0.16	0.44			
APG @ 122°F	12	45	3.87	40	0.00	0.19	0.22	0.41			
APG @ 122°F	23				0.05	0.19	0.24	0.48			
APG @ 122°F	35	35	2.68	40	0.00	0.17	0.08	0.25	0.44	150	0.50
APG @ 122°F	41	40	2.73	40	0.00	0.17	0.13	0.30	0.67	112	0.70
APG @ 122°F	47	45	3.01	40	0.02	0.09	0.11	0.22	----	290	0.21
APG @ 122°F	52	45	1.47	40	0.03	0.00	0.06	0.09	0.48	187	0.50
APG @ 122°F	55	55	1.95	40	0.03	0.03	0.06	0.12	0.91	144	0.60

TABLE II

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. ALA-31246-44

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	45	6.58	40	0.36	0.01	0.20	0.57			
176	1	50	1.98	40	0.22	0.01	0.12	0.35			
176	2	50	2.69	40	0.15	0.00	0.07	0.22			
176	3	50	1.29	40	0.07	0.01	0.05	0.13			
176	4	45	1.28	40	0.14	0.01	0.07	0.22			
176	5	40	1.26	40	0.11	0.00	0.06	0.17			
150	6	45	1.74	40	0.14	0.00	0.08	0.22			
150	12				0.04	0.00	0.04	0.08	----	248	0.45
150	18	50	1.19	40	0.02	0.01	0.03	0.06	----	---	0.45
150	24	45	1.87	40	0.01	0.02	0.03	0.06	----	258	0.35
150	30	50	1.17	40	0.00	0.03	0.05	0.08	----	---	0.00
150	36	50	1.61	40	0.04	0.02	0.06	0.12	----	---	0.20
150	52	35	1.98	40	0.01	0.04	0.01	0.06	0.61	188	0.50
122	6	25	6.84	40	0.40	0.02	0.31	0.63			
122	12	35	5.15	40	0.00	0.29	0.19	0.48	0.61	143	0.65
122	18	30	2.50	40	0.05	0.10	0.21	0.36	0.69	133	0.70
122	24	40	3.16	40	0.02	0.07	0.18	0.27	0.63	120	0.60
122	30	40	2.09	40	0.00	0.06	0.15	0.21	0.55	240	0.35
122	36	45	1.88	40	0.01	0.07	0.13	0.21	0.40	218	0.55
122	52	35	1.82	40	0.05	0.02	0.11	0.18	0.61	166	0.60
122	81	45	1.34	40	0.07	0.02	0.03	0.12	0.60	144	0.60
PA Ambient	12	25	4.60	40	0.35	0.04	0.20	0.59			
PA Ambient	24	45	0.67	40	0.22	0.10	0.21	0.53	0.86	68	0.70
PA Ambient	36	35	4.35	40	0.24	0.09	0.18	0.51	0.60	190	0.25
PA Ambient	48	45	5.10	40	0.17	0.10	0.18	0.45	0.83	117	0.93
PA Ambient	81	45	4.08	40	0.12	0.15	0.22	0.49	1.35	52	1.20
CZ Ambient	6	30	5.77	40	0.28	0.00	0.19	0.47			
CZ Ambient	12	35	4.46	40	0.30	0.02	0.21	0.53			
CZ Ambient	18	35	6.15	40	0.15	0.10	0.19	0.44	0.85	138	0.95
CZ Ambient	24	40	3.31	40	0.12	0.12	0.21	0.45	0.45	152	0.40
CZ Ambient	30	40	2.79	40	0.08	0.17	0.24	0.49	1.08	82	1.00
CZ Ambient	36	40	5.56	40	0.13	0.10	0.25	0.48	0.99	106	1.00
CZ Ambient	42	35	3.78	40	0.09	0.15	0.20	0.44	0.71	149	0.65
CZ Ambient	52	35	4.76	40	0.14	0.11	0.18	0.43	1.15	82	0.87
CZ Ambient	57	45	3.98	40	0.10	0.13	0.21	0.44	0.90	84	0.85
CZ Ambient	64	40	3.77	40	0.06	0.12	0.20	0.38	0.80	56	1.00
CZ Ambient	70	30	3.71	40	0.01	0.12	0.21	0.31	1.50	72	1.10
CZ Ambient	79	40	3.24	40	0.11	0.13	0.19	0.43	1.69	45	----
CZ Ambient	85	35	3.38	40	0.11	0.12	0.19	0.42	1.16	77	1.20

TABLE III

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. ALA-33716-45

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	40	6.49	40	0.36	0.01	0.17	0.54			
176	1	50	2.00	40	0.24	0.02	0.11	0.37			
176	2	50	2.69	40	0.16	0.02	0.11	0.29			
176	3	45	1.40	40	0.12	0.00	0.07	0.19			
176	4	20	1.16	40	0.12	0.01	0.06	0.19			
176	5	55	1.74	40	0.11	0.02	0.06	0.19			
150	6	45	1.51	40	0.15	0.00	0.08	0.23			
150	12	55	2.17	40	0.01	0.00	0.03	0.04	----	266	0.40
150	18	55	1.17	40	0.02	0.00	0.03	0.05	----	---	0.40
150	24	50	2.01	40	0.04	0.00	0.03	0.07	----	251	0.30
150	30	60	1.17	40	0.00	0.04	0.03	0.07	----	---	0.15
150	36	50	1.47	40	0.10	0.02	0.05	0.17	----	---	----
150	52	35	2.21	40	0.01	0.04	0.01	0.06	0.61	188	0.50
122	6	25	7.78	40	0.35	0.02	0.19	0.56			
122	12	35	4.94	40	0.11	0.11	0.20	0.42	0.60	140	0.65
122	18	35	2.66	40	0.00	0.27	0.16	0.43	----	197	0.65
122	24	45	3.27	40	0.04	0.07	0.13	0.24	0.77	97	0.75
122	30	50	1.83	40	0.03	0.08	0.13	0.24	----	---	0.10
122	36	50	1.82	40	0.11	0.07	0.17	0.35	----	290	0.20
122	52	35	1.82	40	0.13	0.05	0.10	0.28	0.65	157	0.65
122	60	50	1.92	40	0.01	0.04	0.08	0.13	0.57	180	0.50
122	66	50	1.41	40	0.04	0.03	0.06	0.13	0.43	254	0.35
122	81	65	1.40	40	0.04	0.02	0.06	0.12	0.57	144	0.55
PA Ambient	12	25	5.17	40	0.39	0.04	0.17	0.60			
PA Ambient	24	45	3.28	40	0.25	0.08	0.18	0.51	0.54	134	0.30
PA Ambient	36	40	6.34	40	0.16	0.12	0.14	0.42	0.85	109	0.90
PA Ambient	48	45	4.38	40	0.16	0.10	0.15	0.41	0.78	141	0.88
PA Ambient	81	45	4.44	40	0.15	0.15	0.17	0.47	1.51	48	1.25
CZ Ambient	6	30	6.89	40	0.43	0.00	0.18	0.61			
CZ Ambient	12	35	4.47	40	0.37	0.02	0.15	0.54			
CZ Ambient	18	35	7.32	40	0.12	0.17	0.19	0.48	0.85	132	0.85
CZ Ambient	24	45	3.49	40	0.11	0.13	0.19	0.43	0.85	36	0.45
CZ Ambient	30	40	3.95	40	0.19	0.12	0.16	0.47	0.80	106	0.90
CZ Ambient	36	40	5.20	40	0.16	0.12	0.18	0.46	0.94	102	0.95
CZ Ambient	42	35	4.24	40	0.13	0.17	0.17	0.46	0.87	100	1.00
CZ Ambient	52	30	5.43	40	0.15	0.11	0.16	0.42	1.54	51	1.00
CZ Ambient	57	40	4.02	40	0.18	0.11	0.17	0.46	1.20	68	1.25
CZ Ambient	64	40	3.79	40	0.13	0.01	0.19	0.33	1.25	52	0.95
CZ Ambient	70	30	4.05	40	0.26	0.06	0.18	0.50	1.05	92	1.10
CZ Ambient	79	40	3.57	40	0.15	0.02	0.17	0.44	1.66	48	----
CZ Ambient	85	40	4.17	40	0.14	0.14	0.20	0.48	1.22	70	1.20

TABLE IV

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. ALA-33746-45

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	45	5.74	40	0.40	0.01	0.20	0.61			
176	1	50	1.57	40	0.23	0.02	0.13	0.38			
176	2	50	3.27	40	0.13	0.00	0.07	0.20			
176	3	45	1.72	40	0.11	0.00	0.07	0.18			
176	4	45	1.20	40	0.13	0.01	0.06	0.20			
176	5	40	1.47	40	0.11	0.00	0.06	0.17			
150	6	45	1.41	40	0.15	0.00	0.08	0.23			
150	12	55	2.02	40	0.07	0.00	0.03	0.10	----	---	0.20
150	18	55	1.17	40	0.03	0.00	0.03	0.06	----	---	0.40
150	24	55	2.06	40	0.04	0.00	0.02	0.06	----	260	0.30
150	30	55	1.25	40	0.00	0.03	0.05	0.08	----	---	0.15
150	36	50	1.37	40	0.12	0.02	0.03	0.17	----	---	0.25
122	6	25	7.74	40	0.32	0.04	0.20	0.56			
122	12	35	4.95	40	0.12	0.16	0.18	0.46	0.57	168	0.60
122	18	30	2.90	40	0.00	0.28	0.21	0.49	----	144	0.80
122	24	40	3.06	40	0.00	0.11	0.18	0.29	0.66	122	0.70
122	30	45	2.05	40	0.00	0.20	0.19	0.39	----	234	0.25
122	36	50	2.29	40	0.05	0.12	0.14	0.31	0.50	180	0.60
122	52	25	1.74	40	0.04	0.06	0.09	0.19	0.55	176	0.50
122	60	50	1.96	40	0.02	0.04	0.08	0.14	0.53	172	0.75
122	66	55	1.27	40	0.01	0.02	0.05	0.08	----	323	0.15
122	81	50	1.36	40	0.02	0.02	0.06	0.10	0.55	1.54	0.60
PA Ambient	12	25	6.10	40	0.40	0.04	0.19	0.63	0.66	161	0.65
PA Ambient	24	45	3.79	40	0.26	0.05	0.24	0.55	0.54	97	0.40
PA Ambient	36	45	5.63	40	0.21	0.11	0.19	0.51	0.73	106	0.75
PA Ambient	48	45	4.17	40	0.21	0.08	0.17	0.46	0.74	121	0.90
PA Ambient	81	50	3.37	40	0.22	0.08	0.19	0.49	1.25	60	1.20
CZ Ambient	6	30	5.61	40	0.40	0.00	0.17	0.57			
CZ Ambient	12	35	3.35	40	0.36	0.01	0.11	0.48	0.90	137	0.90
CZ Ambient	18	40	6.12	40	0.16	0.10	0.19	0.45	0.73	148	0.70
CZ Ambient	24	45	3.44	40	0.22	0.06	0.19	0.47			
CZ Ambient	30	40	3.10	40	0.18	0.12	0.25	0.55	0.70	121	0.90
CZ Ambient	36	40	4.59	40	0.16	0.15	0.23	0.54	0.81	108	0.85
CZ Ambient	42	40	3.55	40	0.10	0.20	0.24	0.54	0.68	128	0.50
CZ Ambient	52	40	4.44	40	0.17	0.10	0.19	0.46	0.61	100	0.80
CZ Ambient	57	40	3.84	40	0.15	0.09	0.19	0.43	1.13	71	1.15
CZ Ambient	64	40	3.96	40	0.09	0.01	0.22	0.32	1.35	52	1.20
CZ Ambient	70	30	3.52	40	0.11	0.05	0.18	0.34	0.93	97	1.00
CZ Ambient	79	55	3.21	40	0.12	0.15	0.20	0.47	1.25	58	0.90
CZ Ambient	85	40	3.29	40	0.15	0.12	0.20	0.47	1.11	80	1.15

TABLE V

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. SUN-19243-45

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	45	3.22	40	0.67	0.04	0.15	0.86			
176	1	50	2.08	40	0.40	0.01	0.16	0.57			
176	2	50	2.60	40	0.23	0.00	0.10	0.33			
176	3	50	1.46	40	0.15	0.01	0.08	0.24			
176	4	45	1.08	40	0.14	0.01	0.06	0.21			
176	5	55	1.29	40	0.12	0.00	0.05	0.17			
176	6	45	1.72	40	0.12	0.00	0.05	0.17			
176	7	40	1.51	40	0.10	0.00	0.09	0.19			
176	8	40	1.27	40	0.16	0.00	0.05	0.21			
150	6	45	1.55	40	0.25	0.01	0.08	0.34			
150	12	55	2.24	40	0.05	0.00	0.07	0.12	----	---	0.35
150	18	45	1.08	40	0.00	0.00	0.03	0.03	----	---	0.30
150	24	50	1.82	40	0.04	0.00	0.03	0.07	----	325	0.20
150	30	55	1.03	40	0.01	0.03	0.02	0.06	----	---	0.10
150	52	35	1.75	40	0.01	0.04	0.01	0.06	0.58	195	0.55
122	6	25	6.60	40	0.63	0.06	0.18	0.87			
122	12	35	4.54	40	0.23	0.25	0.16	0.64	0.78	152	0.80
122	18	35	3.49	40	0.00	0.55	0.18	0.73	----	157	0.75
122	24	35	3.36	40	0.00	0.43	0.18	0.61	0.81	99	0.80
122	30	40	2.07	40	0.02	0.27	0.19	0.48	0.51	238	0.25
122	36	40	2.13	40	0.09	0.14	0.17	0.40	0.50	202	0.55
122	52	30	1.79	40	0.06	0.13	0.16	0.35	0.66	147	0.70
122	60	45	2.00	40	0.00	0.12	0.12	0.24	0.51	204	0.50
122	66	50	1.53	40	0.00	0.10	0.13	0.23	0.54	201	0.40
122	81	50	0.93	40	0.04	0.02	0.10	0.16	0.61	136	0.65
PA Ambient	12	25	3.61	40	0.66	0.04	0.15	0.85	0.62	214	0.30
PA Ambient	24	45	3.44	40	0.54	0.06	0.08	0.68	0.71	87	0.65
PA Ambient	36	45	4.22	40	0.43	0.13	0.13	0.69	0.50	219	0.35
PA Ambient	48	45	3.98	40	0.36	0.15	0.16	0.67	0.70	143	0.58
PA Ambient	81	50	3.58	40	0.33	0.14	0.16	0.63	1.04	73	1.00
CZ Ambient	6	30	5.15	40	0.56	0.01	0.16	0.73			
CZ Ambient	12	35	4.09	40	0.39	0.01	0.15	0.55	----	230	0.50
CZ Ambient	18	30	6.91	40	0.17	0.18	0.19	0.54	0.89	88	0.95
CZ Ambient	24	45	2.29	40	0.20	0.09	0.19	0.48	0.56	128	0.40
CZ Ambient	30	40	2.71	40	0.10	0.18	0.25	0.53	0.91	92	0.95
CZ Ambient	36	40	5.70	40	0.10	0.21	0.18	0.49	1.11	70	0.80
CZ Ambient	42	35	3.91	40	0.15	0.12	0.25	0.52	1.27	85	1.35
CZ Ambient	52	40	4.51	40	0.16	0.16	0.20	0.52	1.55	74	1.18
CZ Ambient	57	40	3.89	40	0.14	0.11	0.20	0.45	0.86	102	0.75
CZ Ambient	64	40	3.94	40	0.02	0.11	0.22	0.35	1.37	53	1.15
CZ Ambient	70	30	3.96	40	0.18	0.08	0.23	0.49	1.16	60	1.20
CZ Ambient	79	35	3.63	40	0.08	0.16	0.22	0.46	1.56	50	----
CZ Ambient	85	35	3.21	40	0.10	0.15	0.23	0.48	1.25	63	1.15

TABLE VI

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. SUN-19246-45

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	50	3.48	40	0.87	0.01	0.11	0.99			
176	1	50	1.64	40	0.85	0.10	0.17	0.72			
176	2	55	2.61	40	0.31	0.10	0.13	0.54			
176	3	50	1.27	40	0.15	0.01	0.08	0.24			
176	4	45	1.37	40	0.16	0.01	0.09	0.26			
176	5	55	1.49	40	0.13	0.00	0.06	0.19			
176	6	45	1.01	40	0.13	0.00	0.05	0.18			
176	7	40	1.37	40	0.10	0.00	0.12	0.22			
176	8	45	0.65	40	0.16	0.00	0.04	0.20			
150	6	45	0.11	40	0.35	0.02	0.09	0.46			
150	12	55	1.74	40	0.07	0.04	0.14	0.25	----	---	0.30
150	18	50	1.05	40	0.07	0.00	0.03	0.10	----	---	0.20
150	24	55	1.29	40	0.04	0.00	0.03	0.07	----	357	0.20
150	30	45	3.71	40	0.01	0.03	0.05	0.09	----	---	0.15
150	36	50	1.34	40	0.03	0.01	0.02	0.06	----	---	0.25
150	52	45	1.46	40	0.01	0.03	0.01	0.05	0.49	218	0.55
122	6	25	6.35	40	0.67	0.05	0.14	0.86			
122	12	35	3.68	40	0.11	0.48	0.14	0.73	0.66	213	0.50
122	18	35	2.87	40	0.00	0.40	0.20	0.60	0.56	151	0.70
122	24	35	3.45	40	0.00	0.43	0.18	0.61	0.78	85	0.71
122	30	60	6.02	40	0.00	0.11	0.18	0.29	0.56	243	0.25
122	36	40	2.04	40	0.08	0.17	0.17	0.42	0.58	175	0.70
122	52	40	1.73	40	0.03	0.14	0.14	0.30	0.62	152	0.65
122	60	45	----	--	0.00	0.11	0.14	0.25	0.49	190	0.60
122	66	40	1.25	40	0.00	0.11	0.14	0.25	0.46	232	0.30
122	81	60	0.83	40	0.03	0.02	0.10	0.15	0.56	158	0.50
PA Ambient	12	40	4.64	40	0.84	0.00	0.11	0.95	----	---	0.20
PA Ambient	24	40	3.37	40	0.56	0.18	0.10	0.84	0.54	80	0.40
PA Ambient	36	50	5.34	40	0.54	0.19	0.10	0.78	0.52	204	0.40
PA Ambient	48	50	3.78	40	0.67	0.10	0.12	0.89	0.41	219	0.33
PA Ambient	81	60	4.33	40	0.53	0.13	0.08	0.74	0.73	75	0.55
CZ Ambient	6	30	4.96	40	0.73	0.12	0.11	0.86			
CZ Ambient	12	35	2.82	40	0.63	0.02	0.10	0.75	----	279	0.40
CZ Ambient	18	30	7.10	40	0.38	0.16	0.12	0.66	0.78	152	0.50
CZ Ambient	24	55	3.72	40	0.25	0.12	0.14	0.51	----	165	0.25
CZ Ambient	30	35	3.08	40	0.23	0.22	0.16	0.61	0.80	100	1.00
CZ Ambient	36	35	5.35	40	0.11	0.25	0.19	0.55	1.04	84	0.80
CZ Ambient	42	30	4.37	40	0.17	0.11	0.20	0.48	0.80	106	0.90
CZ Ambient	52	35	5.42	40	0.09	0.23	0.16	0.48	1.61	52	0.60
CZ Ambient	57	35	4.66	40	0.05	0.14	0.17	0.36	1.06	83	0.70
CZ Ambient	64	40	5.06	40	0.14	0.13	0.18	0.45	1.85	38	1.40
CZ Ambient	70	30	4.22	40	0.17	0.11	0.18	0.46	1.22	62	1.25
CZ Ambient	79	35	4.25	40	0.16	0.24	0.15	0.55	1.85	43	----
CZ Ambient	85	35	4.46	40	0.11	0.15	0.19	0.45	1.66	48	----

TABLE VII

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. RAD-60578-54

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	60	5.52	40	0.90	0.01	0.06	0.97			
176	1	40	3.60	40	0.55	0.10	0.16	0.81			
176	2	65	1.81	40	0.40	0.04	0.15	0.59			
176	3	60	2.77	40	0.27	0.02	0.10	0.39			
176	4	40	2.24	40	0.26	0.03	0.12	0.41			
176	5	55	3.13	40	0.18	0.03	0.09	0.30			
176	6	40	1.43	40	0.19	0.03	0.08	0.30			
176	7	40	1.78	40	0.14	0.03	0.09	0.26			
176	8	40	0.69	40	0.14	0.02	0.08	0.24			
176	9	30	2.66	40	0.12	0.00	0.06	0.18			
176	10	30	2.75	40	0.08	0.00	0.05	0.13			
150	12	45	1.22	40	0.00	0.24	0.13	0.37	----	---	0.25
150	18	60	1.34	40	0.04	0.07	0.10	0.21	----	---	0.20
150	24	55	2.67	40	0.03	0.01	0.03	0.07	----	---	0.15
150	30	60	0.97	40	0.02	0.01	0.02	0.05			
150	36	45	1.37	40	0.06	0.01	0.03	0.10	----	---	0.15
150	52	35	1.67	40	0.03	0.04	0.01	0.08	0.53	192	0.55
122	6	50	3.79	40	0.73	0.03	0.13	0.89			
122	12	45	3.44	40	0.40	0.38	0.15	0.93	----	256	0.30
122	18	50	2.42	40	0.18	0.39	0.19	0.76	----	254	0.25
122	24	50	3.99	40	0.14	0.39	0.17	0.70	0.60	130	1.00
122	30	50	2.19	40	0.16	0.42	0.17	0.72	0.35	236	0.20
122	36	40	2.10	40	0.13	0.39	0.17	0.69	1.51	56	----
122	52	35	2.95	40	0.04	0.46	0.19	0.69	0.70	115	0.65
122	60	45	2.20	40	0.03	0.30	0.19	0.52	0.48	130	0.55
122	66	50	2.12	40	0.00	0.30	0.19	0.49	0.49	154	0.50
122	81	75	1.31	40	0.00	0.16	0.18	0.34	0.70	94	0.65
PA Ambient	12	60	6.81	40	0.89	0.01	0.06	0.96	----	---	0.20
PA Ambient	24	55	3.58	40	0.63	0.18	0.06	0.87	0.76	39	0.35
PA Ambient	36	65	6.89	40	0.65	0.13	0.02	0.80	----	---	0.15
PA Ambient	48	50	4.85	40	0.67	0.15	0.05	0.87	----	180	0.20
PA Ambient	81	70	6.15	40	0.67	0.10	0.03	0.80	0.89	48	0.50
CZ Ambient	6	50	4.79	40	0.86	0.01	0.07	0.94			
CZ Ambient	12	50	4.17	40	0.87	0.03	0.06	0.96	----	262	0.25
CZ Ambient	18	45	5.72	40	0.60	0.17	0.08	0.85	----	---	0.10
CZ Ambient	24	70	5.04	40	0.56	0.09	0.08	0.73	1.19	29	0.35
CZ Ambient	30	55	4.12	40	0.42	0.09	0.15	0.66	0.34	260	0.25
CZ Ambient	36	60	4.66	40	0.26	0.13	0.09	0.48	0.33	229	0.30
CZ Ambient	42	50	4.99	40	0.39	0.09	0.14	0.62	----	24	----
CZ Ambient	52	60	4.57	40	0.49	0.15	0.09	0.73	0.45	140	0.46
CZ Ambient	57	55	7.07	40	0.54	0.13	0.10	0.79	0.62	82	0.40
CZ Ambient	64	55	5.09	40	0.54	0.06	0.12	0.72	1.31	41	0.60
CZ Ambient	70	45	6.41	40	0.26	0.09	0.13	0.48	0.90	164	0.75
CZ Ambient	79	45	2.65	40	0.40	0.13	0.13	0.66	1.11	50	0.75
CZ Ambient	85	35	6.52	40	0.33	0.12	0.14	0.59	2.08	36	----

TABLE VIII

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. BAJ-37579-55

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	60	2.06	40	1.00	0.01	0.07	1.08			
176	1	50	1.62	40	0.61	0.09	0.21	0.91			
176	2	60	1.11	40	0.23	0.01	0.17	0.41			
176	3	65	0.79	40	0.12	0.00	0.06	0.18			
176	4	40	2.28	40	0.17	0.00	0.06	0.23			
176	5	55	2.09	40	0.13	0.00	0.05	0.18			
176	6	45	0.89	40	0.14	0.00	0.05	0.19			
176	7	45	1.15	40	0.14	0.01	0.05	0.20			
176	8	45	1.46	40	0.14	0.01	0.05	0.20			
176	9	40	2.05	40	0.09	0.00	0.05	0.14			
150	12	45	1.22	40	0.16	0.05	0.09	0.30	----	---	0.30
150	18	60	0.79	40	0.05	0.02	0.06	0.13	----	---	0.10
150	24	55	2.43	40	0.08	0.01	0.02	0.11	----	302	0.40
150	30	45	0.71	40	0.02	0.03	0.03	0.08	----	---	0.00
150	36	70	0.92	40	0.03	0.02	0.02	0.07	----	---	----
150	52	45	1.56	40	0.02	0.01	0.04	0.07	0.46	212	0.50
122	6	50	1.70	40	0.94	0.04	0.14	1.12			
122	12	45	1.52	40	0.38	0.35	0.15	0.88	----	282	0.25
122	18	45	0.87	40	0.45	0.27	0.13	0.85	----	265	0.30
122	24	50	2.84	40	0.23	0.29	0.21	0.73	0.53	196	0.45
122	30	60	4.89	40	0.21	0.20	0.23	0.64	----	222	0.85
122	36	40	1.68	40	0.15	0.41	0.22	0.78	0.51	206	0.45
122	52	30	1.55	40	0.03	0.39	0.24	0.66	0.56	168	0.55
122	60	50	1.33	40	0.00	0.30	0.13	0.43	0.59	220	0.50
122	66	50	1.08	40	0.00	0.24	0.27	0.51	----	---	0.15
122	81	70	0.83	40	0.00	0.14	0.24	0.38	----	206	0.45
PA Ambient	12	45	3.62	40	1.01	0.03	0.06	1.10	----	300	0.15
PA Ambient	24	65	3.39	40	0.81	0.06	0.05	0.92	----	216	0.35
PA Ambient	36	60	3.64	40	0.72	0.11	0.02	0.85	----	240	0.25
PA Ambient	48	55	2.92	40	0.74	0.10	0.03	0.87	----	360	0.18
PA Ambient	81	70	3.36	40	0.80	0.11	0.03	0.94	0.58	70	0.40
CZ Ambient	6	45	3.94	40	0.99	0.02	0.06	1.07			
CZ Ambient	12	55	3.08	40	0.96	0.02	0.06	1.04	----	262	0.25
CZ Ambient	18	50	3.90	40	0.84	0.11	0.08	1.03	----	---	0.15
CZ Ambient	24	70	3.18	40	0.79	0.09	0.10	0.98	----	247	0.25
CZ Ambient	30	60	2.75	40	0.69	0.10	0.11	0.90	----	---	0.15
CZ Ambient	36	60	2.74	40	0.83	0.08	0.04	0.95	----	364	0.50
CZ Ambient	42	60	3.00	40	0.75	0.10	0.10	0.95	----	345	0.20
CZ Ambient	52	45	3.01	40	0.76	0.11	0.07	0.94	----	206	0.25
CZ Ambient	57	60	2.55	40	0.76	0.08	0.08	0.92	----	292	0.25
CZ Ambient	64	70	3.06	40	0.64	0.06	0.10	0.80	0.42	100	0.50
CZ Ambient	70	50	3.01	40	0.63	0.09	0.12	0.84	0.42	140	0.35
CZ Ambient	79	55	2.66	40	0.65	0.11	0.12	0.88	0.45	126	0.40
CZ Ambient	85	60	2.82	40	0.44	0.10	0.14	0.68	0.63	216	0.35

TABLE IX

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. IND-39734-56

Storage Location	Time, Mos.	134.5°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	Hours	Stabilizer Content, % DPA	N-NO-DPA	$2NO_2$-DPA	Total	110°C. Taliani Test (N_2) Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	45	3.81	40	0.87	0.16	0.06	1.09			
YPG X-Site	6	50	2.64	40							
YPG Igloo	6	50	2.59	40							
YPG X-Site	12	45	3.62	40	0.75	0.15	0.06	0.96			
YPG Igloo	12	45	3.37	40	0.76	0.15	0.08	0.99			
YPG X-Site	22	50	6.17	40	0.72	0.11	0.10	0.93			
YPG Igloo	22	50	8.03	40	0.69	0.15	0.07	0.91			
YPG X-Site	30	55	2.60	40							
YPG Igloo	30	55	2.64	40							
YPG X-Site	34	50	3.55	40	0.62	0.15	0.08	0.85			
YPG Igloo	34	50	3.64	40	0.69	0.13	0.06	0.88			
YPG X-Site	39	40	2.01	40	0.51	0.17	0.14	0.82	0.53	169	0.50
YPG Igloo	39	45	2.33	40	0.59	0.14	0.13	0.86	0.47	208	0.25
YPG X-Site	45	35	3.20	40	0.55	0.08	0.12	0.75	0.59	172	0.40
YPG Igloo	45	35	3.17	40	0.53	0.08	0.12	0.73	0.67	113	0.55
YPG X-Site	51	35	3.67	40	0.39	0.13	0.15	0.67	1.20	58	1.00
YPG Igloo	51	35	4.63	40	0.37	0.10	0.15	0.62	1.16	72	1.25
YPG X-Site	63	30	1.15	40	0.30	0.15	0.06	0.51	1.15	54	0.90
YPG Igloo	63	30	1.66	40	0.34	0.10	0.17	0.61	1.66	47	1.40
YPG X-Site	69	25	5.60	40	0.26	0.19	0.17	0.62	1.11	81	1.50
YPG Igloo	69	25	7.03	40	0.16	0.19	0.18	0.53	1.11	62	0.95
YPG X-Site	75	35	4.89	40	0.22	0.20	0.14	0.56	2.38	40	----
YPG Igloo	75	35	5.72	40	0.18	0.18	0.18	0.54	2.77	31	----
YPG X-Site	81	35	5.12	40	0.20	0.18	0.16	0.54	1.92	44	----
YPG Igloo	81	35	5.25	40	0.14	0.19	0.17	0.50	2.29	29	----
APG @ 122°F.	6 (2)[a]	40	4.07	40	0.40	0.35	0.13	0.88			
APG @ 122°F.	12 (2)[a]	40	4.13	40	0.15	0.45	0.21	0.81			
APG @ 122°F.	23 (2)[a]				0.19	0.36	0.21	0.76			
APG @ 122°F.	35 (2)[a]	25	3.33	40	0.05	0.47	0.07	0.59	0.95	79	0.78
APG @ 122°F.	39 (1)[a]	30	4.41	40	0.00	0.56	0.19	0.75	0.91	84	0.95
APG @ 122°F.	39 (2)[a]	30	3.43	40	0.14	0.38	0.19	0.71	1.16	78	1.15
APG @ 122°F.	39 (3)[a]	30	4.68	40	0.00	0.69	0.20	0.89	1.20	62	1.05
APG @ 122°F.	47 (2)[a]	35	2.94	40	0.09	0.43	0.19	0.71	0.87	110	1.15
APG @ 122°F.	52 (2)[a]	35	2.99	40	0.07	0.39	0.21	0.67	0.85	93	0.75
Heat Storage	55 (2)[a]	45	2.69	40	0.09	0.31	0.21	0.61	0.73	106	1.00
Remote Storage	(1)[b]	30	5.72	40	0.07	0.55	0.19	0.81	1.08	58	0.85

[a] The propellant test sample was withdrawn from the container number as indicated.
[b] Cans #1 and #3 removed from heat after 39 months @ 122°F. - placed in remote storage area for later testing.

TABLE X

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. IND-BR-39744-56

Storage Location	Time, Mos.	134.5°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	Hours	Stabilizer Content, % DPA	N-NO-DPA	$2NO_2$-DPA	Total	110°C. Taliani Test (N_2) Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	40	4.08	40	0.79	0.10	0.07	0.96			
YPG X-Site	6	35	3.47	40							
YPG Igloo	6	35	3.56	40							
YPG X-Site	12	30	5.05	40	0.51	0.12	0.14	0.77			
YPG Igloo	12	30	5.37	40	0.41	0.18	0.20	0.79			
YPG X-Site	22	35	7.90	40	0.37	0.19	0.14	0.70			
YPG Igloo	22	40	6.73	40	0.37	0.11	0.17	0.65			
YPG X-Site	30	35	5.55	40							
YPG Igloo	30	40	4.92	40							
YPG X-Site	34	35	5.87	40	0.30	0.16	0.18	0.64			
YPG Igloo	34	40	4.57	40	0.31	0.12	0.17	0.60			
YPG X-Site	39	35	4.57	40	0.25	0.21	0.19	0.65	0.98	111	1.15
YPG Igloo	39	35	5.20	40	0.21	0.21	0.21	0.63	0.61	151	0.25
YPG X-Site	45	30	4.48	40	0.28	0.18	0.18	0.64	1.16	85	1.20
YPG Igloo	45	30	5.22	40	0.24	0.17	0.17	0.58	1.14	86	1.03
YPG X-Site	51	35	5.63	40	0.26	0.16	0.16	0.60	1.32	76	1.35
YPG Igloo	51	35	5.93	40	0.18	0.16	0.19	0.53	1.43	54	1.30
YPG X-Site	63	30	5.98	40	0.22	0.13	0.15	0.50	1.20	61	1.10
YPG Igloo	63	35	6.45	40	0.18	0.14	0.18	0.50	1.81	47	1.30
YPG X-Site	69	25	6.72	40	0.19	0.20	0.19	0.58	1.22	80	1.40
YPG Igloo	69	25	5.85	40	0.19	0.19	0.21	0.59	1.25	70	1.50
YPG X-Site	75	35	6.32	40	0.18	0.22	0.15	0.55	2.77	33	----
YPG Igloo	75	35	5.56	40	0.18	0.19	0.19	0.56	2.50	34	----
YPG X-Site	81	40	4.83	40	0.14	0.23	0.14	0.54	2.08	48	----
YPG Igloo	81	35	5.79	40	0.16	0.17	0.19	0.52	1.92	52	----
APG @ 122°F.	6 (2)[a]	30	6.95	40	0.20	0.38	0.16	0.74			
APG @ 122°F.	12 (2)[a]	30	5.79	40	0.07	0.45	0.19	0.71			
APG @ 122°F.	23 (2)[a]				0.04	0.41	0.19	0.64			
APG @ 122°F.	35 (2)[a]	25	3.90	40	0.11	0.33	0.16	0.60	0.88	92	0.88
APG @ 122°F.	41 (2)[a]	35	3.54	40	0.00	0.43	0.17	0.60	0.96	76	0.85
APG @ 122°F.	47 (2)[a]	35	3.44	40	0.04	0.33	0.17	0.54	0.84	98	0.80
APG @ 122°F.	52 (2)[a]	35	3.30	40	0.00	0.32	0.21	0.52	0.96	110	0.75
APG @ 122°F.	55 (2)[a]	40	2.99	40	0.02	0.24	0.17	0.43	0.94	80	0.95

[a] The propellant test sample was withdrawn from the container number as indicated.

TABLE XI

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. RAD-RB-64012-56

Storage Location	Time, Mos.	134.5°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	Hours	Stabilizer Content, % DPA	N-NO-DPA	$2NO_2$-DPA	Total	110°C. Taliani Test (N_2) Slope at 100 mm	Min to 100 mm	Slope at 100 Min.
Initial	0	40	4.88	40	0.20	0.18	0.15	0.53			
YPG X-Site	6	35	3.66	40							
YPG Igloo	6	35	4.16	40							
YPG X-Site	12	35	4.53	40	0.12	0.16	0.20	0.48			
YPG Igloo	12	35	5.42	40	0.18	0.17	0.19	0.54			
YPG X-Site	22	35	6.32	40	0.10	0.11	0.21	0.42			
YPG Igloo	22	40	5.56	40	0.15	0.19	0.19	0.53			
YPG X-Site	30	40	5.18	40							
YPG Igloo	30	40	3.95	40							
YPG X-Site	34	40	5.10	40	0.13	0.15	0.19 •	0.47			
YPG Igloo	34	40	4.88	40	0.14	0.14	0.20	0.48			
YPG X-Site	39	30	3.36	40	0.06	0.24	0.19	0.49	0.71	143	0.90
YPG Igloo	39	30	3.16	40	0.11	0.19	0.19	0.49	0.65	145	0.60
YPG X-Site	45	35	4.06	40	0.06	0.20	0.21	0.47	0.60	142	0.45
YPG Igloo	45	35	4.57	40	0.09	0.18	0.18	0.45	0.87	86	0.83
YPG X-Site	51	40	4.70	40	0.11	0.17	0.19	0.47	0.83	100	0.90
YPG Igloo	51	40	4.62	40	0.07	0.18	0.18	0.43	0.79	95	0.90
YPG X-Site	63	35	5.71	40	0.08	0.16	0.15	0.39	0.75	102	0.85
YPG Igloo	63	35	4.20	40	0.14	0.11	0.18	0.43	0.73	90	0.65
YPG X-Site	69	35	4.33	40	0.11	0.15	0.20	0.46	0.75	94	0.20
YPG Igloo	69	35	4.10	40	0.16	0.12	0.20	0.48	0.90	85	1.00
YPG X-Site	75	50	3.87	40	0.05	0.20	0.13	0.38	1.37	51	0.85
YPG Igloo	75	50	4.34	40	0.08	0.19	0.15	0.42	1.56	48	1.00
YPG X-Site	81	40	4.18	40	0.03	0.22	0.18	0.43	1.17	72	1.01
YPG Igloo	81	40	3.95	40	0.08	0.18	0.18	0.44	1.25	68	1.20
APG @ 122°F.	2 (2)[a]	25	4.76	40	0.38	0.03	0.23	0.64			
APG @ 122°F.	6 (2)[a]	30	6.49	40	0.08	0.27	0.23	0.58			
APG @ 122°F.	11 (1)[a]	45	4.00	40	0.00	0.25	0.18	0.43			
APG @ 122°F.	12 (2)[a]	40	4.04	40	0.00	0.32	0.21	0.53			
APG @ 122°F.	23 (1)[a]				0.00	0.24	0.33	0.57			
APG @ 122°F.	23 (2)[a]				0.00	0.19	0.24	0.43			
APG @ 122°F.	35 (2)[a]	30	2.82	40	0.00	0.16	0.18	0.34	0.51	156	0.53
APG @ 122°F.	39 (1)[a]	40	3.07	40	0.00	0.27	0.17	0.44	0.74	90	0.60
APG @ 122°F.	47 (3)[a]	45	1.64	40	0.02	0.08	0.13	0.23	0.51	178	0.55
APG @ 122°F.	52 (3)[a]	50	2.00	40	0.00	0.07	0.17	0.24	----	278	0.20
APG Remote Storage	55 (3)[b]	50	1.77	40	0.01	0.05	0.14	0.20	0.43	222	0.30
APG Remote Storage	(1)[b]	35	4.91	40	0.00	0.25	0.16	0.41	0.66	92	0.55

[a] The propellant sample was withdrawn from the container number as indicated.
[b] Can No. D-2 removed to remote storage after 32 months @ 122°F.; Can No. D-1 removed to remote storage after 39 months @ 122°F.

TABLE XII

Ambient and Accelerated Aging Effects on Propellant, M6, Lot No. PAE-R-21406-56

Storage Location	Time,Mos.	134.5°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	Hours	Stabilizer Content, % DPA	N-NO-DPA	$2NO_2$-DPA	Total	110°C. Taliani Test (N_2) Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	35	5.89	40	0.33	0.65	0.13	1.11			
YPG X-Site	6	35	3.53	40							
YPG Igloo	6	35	3.72	40							
YPG X-Site	12	35	8.16	40	0.48	0.20	0.23	0.91			
YPG Igloo	12	35	7.02	40	0.29	0.57	0.17	1.03			
YPG X-Site	22	40	8.22	40	0.34	0.43	0.20	0.97			
YPG Igloo	22	35	8.03	40	0.12	0.56	0.16	0.84			
YPG X-Site	30	35	4.95	40							
YPG Igloo	30	35	5.35	40							
YPG X-Site	34	35	6.31	40	0.24	0.56	0.18	0.98			
YPG Igloo	34	40	6.70	40	0.23	0.56	0.17	0.96			
YPG X-Site	39	30	3.79	40	0.21	0.63	0.19	1.03	1.10	91	0.75
YPG Igloo	39	25	4.01	40	0.23	0.63	0.18	1.04	1.09	85	1.10
YPG X-Site	45	30	5.53	40	0.22	0.57	0.16	0.95	1.39	68	2.12
YPG Igloo	45	30	5.62	40	0.21	0.62	0.18	1.01	1.13	76	1.23
YPG X-Site	51	25	5.68	40	0.24	0.52	0.18	0.94	1.61	67	1.45
YPG Igloo	51	25	6.67	40	0.18	0.54	0.18	0.90	1.58	48	----
YPG X-Site	63	35	7.58	40	0.11	0.44	0.09	0.64	1.69	42	1.50
YPG Igloo	63	30	7.36	40	0.24	0.40	0.18	0.82	1.66	46	1.35
YPG X-Site	69	30	5.49	40	0.26	0.45	0.18	0.89	1.47	50	1.35
YPG Igloo	69	30	4.87	40	0.33	0.35	0.19	0.87	1.72	44	----
YPG X-Site	75	35	6.97	40	0.24	0.53	0.15	0.92	2.50	36	----
YPG Igloo	75	40	6.61	40	0.23	0.46	0.13	0.82	2.77	34	----
YPG X-Site	81	30	6.86	40	0.10	0.58	0.18	0.86	2.17	47	-----
YPG Igloo	81	30	6.82	40	0.16	0.52	0.18	0.86	2.17	48	----
APG @ 122°F.	6 (2)[a]	25	11+	40	0.06	0.78	0.17	1.01			
APG @ 122°F.	12 (2)[a]	25	6.25	40	0.00	0.81	0.23	1.04			
APG @ 122°F.	23 (2)[a]				0.00	0.73	0.25	0.98			
APG @ 122°F.	23 (3)[a]				0.00	0.88	0.19	1.07			
APG @ 122°F.	32 (3)[a]	25	4.27	40	0.03	0.80	0.20	1.03			
APG @ 122°F.	35 (2)[a]	25	3.47	40	0.00	0.43	0.09	0.52	0.94	78	0.90
APG @ 122°F.	41 (2)[a]	35	2.36	40	0.00	0.50	0.23	0.73	1.07	72	0.90
APG @ 122°F.	47 (2)[a]	35	2.54	40	0.01	0.36	0.24	0.61	1.00	82	0.95
APG @ 122°F.	52 (1)[a]	35	2.99	40	0.06	0.22	0.24	0.52	0.94	82	0.85
APG Remote Storage	55 (2)[b]	40	2.94	40	0.06	0.24	0.24	0.54	0.94	80	1.10
APG Remote Storage	(3)[b]	30	6.67	40	0.00	0.80	0.21	1.01	1.56	49	1.15

[a] The propellant sample was withdrawn from the container number as indicated.
[b] Can No. E-3 removed to remote storage after 23 months @ 122°F.

TABLE XIII

Ambient and Accelerated Aging Effects on Propellant, IMR, Lot No. OKLA-29220-45

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp. °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial		30	2.37	40	0.22	0.01	0.08	0.31			
176	.25	25	1.66	40	0.14	0.01	0.09	0.24			
176	.50	25	1.28	40	0.07	0.01	0.07	0.15			
176	.75	30	1.63	40	0.05	0.01	0.05	0.11			
176	1	30	2.62	40	0.02	0.00	0.05	0.07			
150	2	30	2.06	40	0.09	0.00	0.09	0.18			
150	2.5[a]				0.04	0.01	0.03	0.08			
122	6	20	2.55	40	0.10	0.01	0.07	0.18			
122	12	10	6.69	40	0.03	0.03	0.00	0.06	0.75	109	0.70
122	18	25	1.92	40	0.04	0.00	0.00	0.04	----	---	0.15
122	24	35	2.62	40	0.03	0.02	0.03	0.08	----	260	0.35
122	30				0.00	0.02	0.03	0.05			
PA Ambient	12	25	2.59	40	0.23	0.01	0.08	0.32	----	234	0.35
PA Ambient	24	30	1.97	40	0.08	0.10	0.10	0.28	----	---	0.15
PA Ambient	36	30	2.08	40	0.11	0.05	0.10	0.26	----	---	0.15
PA Ambient	48	30	1.81	40	0.13	0.09	0.08	0.30	0.52	193	0.50
PA Ambient	81	45	1.90	40	0.11	0.09	0.10	0.30	0.69	114	0.70
CZ Ambient	6	30	1.91	40	0.26	0.01	0.08	0.35			
CZ Ambient	12	30	1.74	40	0.21	0.02	0.09	0.32	----	247	0.35
CZ Ambient	18	20	2.69	40	0.01	0.14	0.12	0.27	----	215	0.45
CZ Ambient	24	20	3.85	40	0.11	0.05	0.13	0.29	----	---	0.10
CZ Ambient	30	40	1.61	40	0.04	0.11	0.14	0.29	2.05	210	0.45
CZ Ambient	36	25	2.56	40	0.00	0.19	0.08	0.27	0.60	142	0.50
CZ Ambient	42	30	2.55	40	0.01	0.09	0.11	0.21	0.60	170	0.45
CZ Ambient	52	20	2.57	40	0.00	0.19	0.10	0.29	4.00	72	0.55
CZ Ambient	57	35	2.69	40	0.00	0.04	0.09	0.13	0.86	222	0.40

a After 2-1/2 months storage red fumes were observed.

TABLE XIII (Cont)

Ambient and Accelerated Aging Effects on Propellant, IMR, Lot No. OKLA-29220-45

Storage Location	Time, Mos.	134.5°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	Hours	Stabilizer Content, % DPA	N-NO-DPA	$2NO_2$-DPA	Total	110°C. Taliani Test (N_2) Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
YPG X-Site	6	25	1.80	40							
YPG Igloo	6	25	1.83	40							
YPG X-Site	12	35	6.58	40	0.08	0.10	0.13	0.31			
YPG Igloo	12	35	2.73	40	0.08	0.10	0.10	0.28			
YPG X-Site	22	30	3.28	40	0.17	0.09	0.11	0.37			
YPG Igloo	22	30	3.25	40	0.13	0.10	0.13	0.36			
YPG X-Site	30	25	2.44	40							
YPG Igloo	30	25	2.15	40							
YPG X-Site	34	15	2.90	40	0.00	0.11	0.19	0.30			
YPG Igloo	34	20	3.17	40	0.03	0.11	0.13	0.27			
YPG X-Site	39	25	2.07	40	0.00	0.12	0.18	0.30			
YPG Igloo	39	25	2.13	40	0.00	0.12	0.13	0.25			
YPG X-Site	45	25	2.14	40	0.00	0.08	0.16	0.24	0.52	158	0.53
YPG Igloo	45	20	2.29	40	0.00	0.08	0.13	0.21	0.52	177	0.50
YPG X-Site	51	20	2.90	40	0.01	0.10	0.07	0.18	0.49	148	0.50
YPG Igloo	51	15	2.64	40	0.01	0.04	0.02	0.07	0.90	74	0.70
YPG X-Site	63	25	2.78	40	0.02	0.08	0.04	0.14	----	270	0.50
YPG Igloo	63	15	7.92	40	0.04	0.03	0.00	0.07	2.00	34	1.10
APG @ 122°F.	2	10	3.01	40	0.28	0.07	0.04	0.39			
APG @ 122°F.	6	20	3.98	40	0.00	0.16	0.15	0.31			
APG @ 122°F.	7	25	4.22	40	0.05	0.11	0.06	0.22			
APG @ 122°F.	32	10	7.97	40	0.00	0.04	0.02	0.06			

TABLE XIV

Ambient and Accelerated Aging Effects on Propellant, IMR, Lot No. OKLA-29221-45

Storage		134.5°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	DPA	N-NO-DPA	$2NO_2$-DPA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	35	2.60	40	0.23	0.01	008	0.32			
176	.25	25	2.26	40	0.13	0.01	0.08	0.22			
176	.50	25	1.57	40	0.08	0.01	0.07	0.16			
176	.75	30	2.06	40	0.03	0.01	0.06	0.10			
176	1	15	11+	24	0.02	0.00	0.04	0.06			
150	2	20	3.46	40	0.05	0.00	0.04	0.09			
150	2.5[a]				0.05	0.00	0.05	0.10			
122	6	20	2.32	40	0.14	0.01	0.10	0.25			
122	12	5	11+	16	0.04	0.03	0.00	0.07	2.22	10	----
122	18	20	2.77	40	0.04	0.00	0.00	0.04	----	240	0.30
122	24	30	3.16	40	0.00	0.01	0.03	0.04	----	---	0.25
122	30	30	1.79	40	0.03	0.01	0.01	0.05	0.38	262	0.35
PA Ambient	12	30	2.17	40	0.25	0.01	0.08	0.34	----	---	0.15
PA Ambient	24	45	2.17	40	0.05	0.15	0.10	0.30	----	224	0.45
PA Ambient	36	30	2.37	40	0.12	0.05	0.08	0.25	----	---	0.15
PA Ambient	48	30	1.30	40	0.06	0.13	0.08	0.27	0.46	237	0.38
PA Ambient	81	40	1.92	40	0.09	0.12	0.11	0.32	0.66	130	0.65
CZ Ambient	6	30	2.60	40	0.24	0.01	0.08	0.33			
CZ Ambient	12	30	2.17	40	0.21	0.02	0.08	0.31			
CZ Ambient	18	20	3.59	40	0.07	0.15	0.07	0.29	----	207	0.45
CZ Ambient	24	25	3.23	40	0.07	0.13	0.12	0.32	----	---	0.15
CZ Ambient	30	40	1.62	40	0.07	0.09	0.12	0.28	0.40	180	0.50
CZ Ambient	36	25	2.50	40	0.00	0.18	0.08	0.26	0.54	190	0.35
CZ Ambient	42	25	2.54	40	0.00	0.17	0.13	0.30	----	350	0.20
CZ Ambient	52	25	2.44	40	0.05	0.13	0.08	0.26	0.56	138	0.65
CZ Ambient	57	35	1.81	40	0.06	0.12	0.09	0.27	0.62	122	0.50
CZ Ambient	64	25	2.34	40	0.04	0.11	0.10	0.25	0.65	87	0.75
CZ Ambient	70	20	2.42	40	0.01	0.10	0.11	0.22	----	243	0.25
CZ Ambient	79	35	2.24	40	0.00	0.12	0.11	0.33	0.73	96	0.65
CZ Ambient	85	25	2.49	40	0.00	0.10	0.10	0.20	0.91	72	0.85

[a] After 2-1/2 months storage red fumes were observed.

TABLE XV

Ambient and Accelerated Aging Effects on Propellant, IMR, Lot No. OKLA-29250-45

Storage Location	Time, Mos.	134.5°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	Hours	Stabilizer Content, % DPA	N-NO-DPA	$2NO_2$-DPA	Total	110°C. Taliani Test (N_2) Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	35	1.37	40	0.43	0.10	0.05	0.58			
YPG X-Site	6	25	1.48	40							
YPG Igloo	6	25	1.16	40							
YPG X-Site	12	35	3.05	40	0.16	0.15	0.05	0.36			
YPG Igloo	12	30	2.92	40	0.13	0.13	0.08	0.34			
YPG X-Site	22	25	3.29	40	0.03	0.22	0.11	0.36			
YPG Igloo	22	30	3.39	40	0.09	0.11	0.10	0.30			
YPG X-Site	30	30	2.50	40							
YPG Igloo	30	30	3.29	40							
YPG X-Site	34	35	2.60	40	0.12	0.15	0.11	0.38			
YPG Igloo	34	35	2.46	40	0.07	0.19	0.11	0.37			
YPG X-Site	39	30	1.87	40	0.03	0.22	0.11	0.36	----	303	0.30
YPG Igloo	39	30	1.91	40	0.04	0.20	0.11	0.35	----	238	0.30
YPG X-Site	45	25	2.16	40	0.00	0.18	0.07	0.25	0.68	134	0.53
YPG Igloo	45	25	2.21	40	0.06	0.14	0.06	0.26	0.64	127	0.70
YPG X-Site	51	25	2.27	40	0.09	0.15	0.10	0.34	----	296	0.30
YPG Igloo	51	25	2.30	40	0.09	0.13	0.08	0.30	0.55	140	0.70
YPG X-Site	63	30	2.38	40	0.06	0.15	0.10	0.31	----	244	0.20
YPG Igloo	63	30	2.38	40	0.02	0.18	0.10	0.30	0.58	132	0.55
YPG X-Site	69	30	5.49	40	0.06	0.14	0.10	0.30	1.47	50	1.35
YPG Igloo	69	30	4.87	40	0.07	0.11	0.10	0.28	1.72	44	----
YPG X-Site	75	25	2.29	40	0.02	0.17	0.10	0.29	0.78	97	0.70
YPG Igloo	75	35	2.72	40	0.05	0.17	0.06	0.28	0.83	82	0.70
YPG X-Site	81	20	2.32	40	0.01	0.17	0.10	0.28	0.51	186	0.50
YPG Igloo	81	20	2.40	40	0.01	0.17	0.11	0.29	0.65	130	0.90
APG @ 122°F.	2 (2)[a]	10	2.39	40	0.29	0.08	0.07	0.44			
APG @ 122°F.	6 (2)[a]	25	4.28	40	0.06	0.33	0.10	0.49			
APG @ 122°F.	7	25	2.63	40	0.16	0.19	0.08	0.43			
APG Remote Storage	32 (3)[b]	30	1.48	40	0.00	0.26	0.12	0.38			
APG Remote Storage	52 (3)[b]	30	3.70	40	0.00	0.18	0.11	0.29			

[a] The propellant sample was withdrawn from the container number as indicated.
[b] Cans Nos. 1, 2 and 3 removed from storage at 122°F. after 8 months - Cans Nos. 1 and 2 were destroyed, Can No. 3 was placed in remote storage.

TABLE XVI

Ambient and Accelerated Aging Effects on Propellant, M2, Lot No. RAD-60326-54

Storage		180°C. Heat Test	90°C. Vacuum Stability		Stabilizer Content, %				110°C. Taliani Test (N_2)		
Temp., °F.	Time, Mos.	Salmon Pink, Min.	Ml. Gas	Hours	EC	PEN	2-NEA	Total	Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	125	4.16	40	0.51	0.01	0.00	0.52			
176	.25	95	4.10	40	0.33	0.02	0.00	0.35			
176	.50	95	4.17	40	0.29	0.02	0.00	0.31			
176	.75	85	5.65	40	0.23	0.03	0.00	0.26			
176	1	110	6.27	40	0.16	0.01	0.00	0.17			
150	2	140	3.34	40	0.34	0.01	0.00	0.35			
150	3	115	3.81	40	0.30	0.02	0.00	0.32			
150	4	90	4.11	40	0.26	0.05	0.00	0.31			
150	5	110	11+	40	0.14	0.02	0.01	0.17			
150	6	120	3.05	40	0.14	0.06	0.00	0.20			
150	7	95	1.94	40	0.13	0.04	0.07	0.17			
150	8	110	3.85	40	0.12	0.01	0.01	0.14			
150	9	95	3.99	40	0.12	0.01	0.01	0.14			
150	10	110	5.73	40	0.17	0.02	0.00	0.19			
122	6	95	3.04	40	0.54	0.03	0.00	0.57			
122	12	100	4.60	40	0.42	0.03	0.00	0.45	0.63	182	0.65
122	18	135	3.00	40	0.35	0.03	0.00	0.38	0.61	183	0.55
122	24	90	5.46	40	0.28	0.08	0.00	0.36	----	251	0.30
122	30	95	1.59	40	0.32	0.05	0.01	0.38	0.59	270	0.25
122	36	95	3.48	40	0.33	0.04	0.01	0.38	0.60	224	0.35
122	52	110	2.73	40	0.04	0.12	0.06	0.22	0.73	174	0.60
PA Ambient	12	90	3.18	40	0.35	0.02	0.00	0.37			
PA Ambient	24	90	3.26	40	0.76	0.01	0.00	0.77	0.50	194	0.45
PA Ambient	36	100	3.38	40	0.46	0.01	0.00	0.47	0.64	182	0.75
PA Ambient	48	110	3.47	40	0.38	0.01	0.00	0.39	0.56	313	0.13
PA Ambient	81	75	3.40	40	0.50	0.02	0.00	0.52	0.72	104	0.75
CZ Ambient	6	115	4.37	40	0.50	0.01	0.00	0.51			
CZ Ambient	12	90	2.90	40	0.53	0.02	0.00	0.55	0.78	162	0.70
CZ Ambient	18	95	6.26	40	0.54	0.02	0.00	0.56	0.84	174	0.65
CZ Ambient	24	100	2.43	40	0.53	0.01	0.00	0.54	----	---	0.10
CZ Ambient	30	140	2.49	40	0.40	0.02	0.00	0.42	0.50	232	0.35
CZ Ambient	36	85	3.66	40	0.43	0.02	0.00	0.45	----	---	0.05
CZ Ambient	42	95	4.10	40	0.55	0.03	0.00	0.58	3.23	195	0.35
CZ Ambient	52	95	3.78	40	0.61	0.00	0.00	0.61	0.69	122	0.75
CZ Ambient	57	90	3.55	40	0.49	0.01	0.00	0.50	0.66	172	0.50
CZ Ambient	64	85	6.50	40	0.52	0.01	0.00	0.53	----	---	0.10
CZ Ambient	70	60	4.10	40	0.41	0.02	0.00	0.43	0.85	202	0.40
CZ Ambient	79	75	7.58	40	0.50	0.02	0.00	0.52	0.79	120	0.85
CZ Ambient	85	105	4.30	40	0.41	0.01	0.00	0.42	0.98	98	1.00

TABLE XVII

Ambient and Accelerated Aging Effects on Propellant, M9, Lot No. MRBC-39649-56

Storage Temp., °F.	Time, Mos.	120°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	Hours	Stabilizer Content, % EC	PEN	2-NEA	Total	110°C. Taliani Test (N_2) Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	45	6.60	40	0.55	0.01	0.00	0.56			
176	.25	35	6.30	40	0.28	0.04	0.08	0.40			
176	.50	40	5.21	40	0.15	0.03	0.02	0.20			
176	.75	40	5.49	40	0.01	0.02	0.03	0.06			
150	1	40	6.89	40	0.48	0.06	0.01	0.55			
150	2	45	7.46	40	0.21	0.01	0.00	0.22			
150	3	40	6.09	40	0.11	0.02	0.04	0.17			
150	4	40	11+	40	0.11	0.01	0.01	0.13			
150	5	45	4.68	40	0.07	0.03	0.02	0.12			
150	6	40	4.76	40	0.08	0.01	0.02	0.11			
150	7	35	5.34	40	0.13	0.02	0.02	0.17			
150	8	30	4.22	40	0.02	0.03	0.01	0.06			
150	9	30	3.96	40	0.02	0.03	0.01	0.06			
122	6	45	6.85	40	0.53	0.05	0.01	0.59			
122	12	35	11+	40	0.43	0.01	0.00	0.44			
122	18	30	6.81	40	0.38	0.04	0.00	0.42			
122	24	30			0.18	0.08	0.00	0.26			
122	30	50	5.18	40	0.10	0.04	0.02	0.16			
122	36	35	5.29	40	0.10	0.02	0.02	0.14			
122	42	35	4.69	40	0.15	0.02	0.02	0.19			
122	48	35	5.04	40	0.06	0.02	0.02	0.10			
PA Ambient	12	30	5.30	40	0.79	0.02	0.00	0.81	----	210	0.25
PA Ambient	24	35	5.53	40	0.74	0.03	0.00	0.77	----	293	0.10
PA Ambient	36	35	5.98	40	0.68	0.00	0.01	0.69	1.17	164	0.60
PA Ambient	48	40	5.88	40	0.75	0.02	0.00	0.77	1.33	92	1.48
PA Ambient	81	30	6.05	40	0.72	0.03	0.00	0.75	1.78	58	----
CZ Ambient	6	45	8.14	40	0.61	0.01	0.00	0.62			
CZ Ambient	12	40	4.78	40	0.76	0.02	0.00	0.78	1.57	83	1.35
CZ Ambient	18	30	11+	40	0.67	0.04	0.00	0.71	1.47	76	1.70
CZ Ambient	24	35	4.24	40	0.64	0.03	0.00	0.67	0.99	146	0.50
CZ Ambient	30	45	4.56	40	0.52	0.08	0.08	0.60	1.26	103	1.30
CZ Ambient	36	35	6.79	40	0.61	0.05	0.00	0.66	1.14	144	1.15
CZ Ambient	42	30	6.18	40	0.62	0.04	0.00	0.66	1.64	98	1.80
CZ Ambient	52	50	6.96	40	0.54	0.02	0.00	0.56	1.59	62	1.65
CZ Ambient	57	40	5.34	40	0.49	0.03	0.00	0.52	1.40	92	1.35
CZ Ambient	64	45	7.23	40	0.52	0.03	0.00	0.55	1.43	89	1.55
CZ Ambient	70	50	6.42	40	0.52	0.04	0.01	0.57	1.25	164	0.75
CZ Ambient	79	50	6.64	40	0.50	0.04	0.00	0.54	1.78	55	1.75
CZ Ambient	85	35	6.66	40	0.54	0.03	0.00	0.57	1.56	62	1.30

TABLE XVIII

Ambient and Accelerated Aging Effects on Propellant, M10, Lot No. RAD-60310-54

Storage Temp., °F.	Time, Mos.	134.5°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	Hours	Stabilizer Content, % DPA	N-NO-DPA	$2NO_2$-DPA	Total	110°C. Taliani Test (N_2) Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	80	1.13	40	0.77	0.18	0.02	0.97			
176	1	70	1.74	40	0.26	0.11	0.06	0.43			
176	2	70	1.99	40	0.16	0.06	0.04	0.26			
176	3	50	2.59	40	0.04	0.04	0.00	0.08			
150	6	50	1.67	40	0.15	0.04	0.04	0.23			
150	12	45	1.04	40	0.00	0.09	0.05	0.14	0.46	155	0.55
150	18	60	2.93	40	0.04	0.04	0.00	0.08	0.59	120	0.65
150	24				0.00	0.03	0.00	0.03			
122	6	45	1.98	40	0.46	0.17	0.01	0.64			
122	12	45	3.03	40	0.00	0.56	0.11	0.67	0.77	100	0.80
122	18	55	2.09	40	0.34	0.04	0.13	0.51	2.13	51	----
122	24	50			0.00	0.15	0.15	0.30	0.64	101	0.55
122	36	45	1.72	40	0.00	0.28	0.14	0.42	0.80	86	0.75
122	52	50	1.52	40	0.01	0.12	0.12	0.25	0.88	101	4.90
122	60	65	1.84	40	0.00	0.11	0.10	0.21	1.13	64	0.90
122	66	65	2.01	40	0.00	0.05	0.04	0.09	0.61	100	0.55
122	81	80	1.65	40	0.00	0.03	0.05	0.08	1.04	72	0.90
PA Ambient	12	60	1.37	40	0.73	0.10	0.01	0.84	----	103	0.50
PA Ambient	24	70	1.63	40	0.52	0.27	0.05	0.84	2.33	23	----
PA Ambient	36	60	1.47	40	0.52	0.25	0.03	0.80	0.80	72	0.90
PA Ambient	48	70	1.25	40	0.53	0.23	0.04	0.80	1.04	70	0.65
PA Ambient	81	80	1.43	40	0.49	0.17	0.06	0.72	1.13	60	0.85
CZ Ambient	6	60	1.84	40	0.74	0.18	0.01	0.93			
CZ Ambient	12	55	1.41	40	0.68	0.19	0.01	0.88	0.50	121	0.50
CZ Ambient	18	45	1.65	40	0.33	0.19	0.08	0.60	1.28	46	0.80
CZ Ambient	24	85	1.27	40	0.40	0.06	0.10	0.56	1.09	60	0.85
CZ Ambient	30	55	1.14	40	0.22	0.16	0.15	0.53	1.40	59	1.10
CZ Ambient	36	45	2.36	40	0.18	0.12	0.08	0.38	1.31	46	0.85
CZ Ambient	42	55	2.85	40	0.06	0.24	0.14	0.44	1.03	65	0.65
CZ Ambient	52	65	2.40	40	0.14	0.26	0.10	0.50	1.26	72	1.00
CZ Ambient	57	55	0.71	40	0.11	0.21	0.10	0.44	1.00	100	1.00
CZ Ambient	64	55	2.12	40	0.11	0.18	0.11	0.40	1.11	46	0.55
CZ Ambient	70	50	2.21	40	0.12	0.21	0.12	0.45	0.80	138	0.65
CZ Ambient	79	60	1.39	40	0.13	0.24	0.15	0.52	1.35	56	1.20
CZ Ambient	85	60	2.11	40	0.14	0.21	0.14	0.49	1.51	48	----

TABLE XIX

Ambient and Accelerated Aging Effects on Propellant, M15, Lot No. RAD-60387-56

Storage Temp., °F.	Time, Mos.	120°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	Hours	Stabilizer Content, % EC	PEN	2-NEA	Total	110°C. Taliani Test (N_2) Slope at 100 mm	Min. to 100 mm	Slope at 100 Min.
Initial	0	115	2.17	40	5.74	0.02	0.01	5.77			
176	1	150	1.95	40	5.12	0.09	0.02	5.23			
176	2	130	3.13	40	4.49	0.16	0.05	4.70			
176	3	90	4.35	40	3.87	0.23	0.05	4.15			
176	4	45	1.65	40	3.70	0.35	0.09	4.14			
176	5	45	11+	16	2.54	0.55	0.09	3.18			
176	6	40	11+	16	2.85	0.55	0.05	3.45			
176	7	25	11+	16	2.61	0.68	0.06	3.35			
176	8	30	11+	16	2.72	0.61	0.05	3.38			
176	9	25	11+	24	2.60	0.37	0.06	3.03			
176	10	30	11+	16	2.46	0.30	0.05	2.81			
150	6	120	1.90	40	5.52	0.11	0.04	5.67			
150	12	95	5.96	40	4.81	0.13	0.07	5.01	0.89	128	0.85
150	18	90	2.80	40	3.05	0.15	0.06	3.26	0.85	128	0.85
150	24	60	7.85	40	3.18	0.20	0.07	3.45	1.03	65	1.50
150	30	55	1.14	40	2.30	0.19	0.15	2.64			
150	36	45	9.23	40	3.30	0.36	0.15	3.81	----	---	0.10
150	52	65	6.40	40	2.30	0.20	0.14	2.64	1.60	64	1.55
122	6	90	1.73	40	5.36	0.03	0.00	5.39			
122	12	95	1.67	40	4.87	0.02	0.00	4.89	0.70	148	0.70
122	18	130	1.08	40	4.92	0.04	0.01	4.97	----	228	0.40
122	24	95	2.77	40	5.39	0.08	0.00	5.47	0.74	206	0.50
122	30	60	0.99	40	5.73	0.01	0.01	5.75	0.66	211	0.50
122	36	115	1.39	40	4.26	0.04	0.01	4.31	0.73	202	0.50
122	52	105	1.77	40	5.39	0.01	0.00	5.40	0.83	156	0.65
122	60	110	11+	16	5.56	0.04	0.03	5.63	0.77	158	0.65
122	66	100	11+	24	5.36	0.03	0.03	5.42	0.69	200	0.60
122	81	65	1.22	40					0.93	120	0.85
PA Ambient	12	90	1.76	40	3.98	0.02	0.00	4.00	----	212	0.40
PA Ambient	24	85	1.62	40	5.45	0.01	0.01	5.47	0.62	181	0.50
PA Ambient	36	90	1.50	40	5.28	0.00	0.01	5.29	0.75	169	0.90
PA Ambient	48	105	1.64	40	5.59	0.01	0.00	5.60	0.61	188	0.68
PA Ambient	81	80	1.52	40	5.84	0.03	0.00	5.87	0.90	110	0.95
CZ Ambient	6	110	2.08	40	3.66	0.18	0.00	3.84			
CZ Ambient	12	95	1.54	40	5.27	0.03	0.00	5.30	----	300	0.30
CZ Ambient	18	90	2.35	40	5.30	0.06	0.00	5.36	0.75	146	0.75
CZ Ambient	24	70	1.02	40	4.10	0.18	0.00	4.28	1.43	179	0.60
CZ Ambient	30	125	1.24	40	5.40	0.14	0.00	5.54	0.72	274	0.45
CZ Ambient	36	85	2.05	40	4.95	0.03	0.00	4.98	0.78	217	0.45
CZ Ambient	42	105	1.40	40	5.83	0.03	0.00	5.86	0.76	154	0.50
CZ Ambient	52	110	2.01	40	5.77	0.01	0.00	5.78	0.82	132	0.80
CZ Ambient	57	105	1.31	40	5.52	0.03	0.00	5.55	0.77	152	0.65
CZ Ambient	64	90	3.17	40	5.18	0.04	0.00	5.22	0.77	142	0.95
CZ Ambient	70	105	1.77	40	5.69	0.04	0.01	5.74	0.89	194	0.50
CZ Ambient	79	70	1.75	40	5.68	0.07	0.00	5.75	0.87	116	1.00
CZ Ambient	85	65	1.82	40	6.03	0.03	0.00	6.06	0.87	116	0.80

TABLE XX

Ambient and Accelerated Aging Effects on Propellant, T28, Lot No. RAD-38145-56

Storage Temp. °F.	Storage Time, Mos.	120°C. Heat Test Salmon Pink, Min.	90°C. Vacuum Stability Ml. Gas	90°C. Vacuum Stability Hours	Stabilizer Content, % EC	Stabilizer Content, % PEN	Stabilizer Content, % 2-NEA	Stabilizer Content, % Total	110°C. Taliani Test (N_2) Slope at 100 mm	110°C. Taliani Test (N_2) Min. to 100 mm	110°C. Taliani Test (N_2) Slope at 100 Min.
Initial	0	70	6.58	40	5.71	0.03	0.01	5.75			
176	1	30	11+	16	4.03	0.28	0.01	4.32			
176	2	25	11+	16	2.69	0.91	0.03	3.63			
176	3	15	11+	18	3.23	0.52	0.03	3.78			
176	4	20	7.11	40	3.30	0.47	0.02	3.79			
150	6	25	11+	16	2.48	1.27	0.03	3.78			
150	12	25	11+	16	4.73	0.25	0.02	5.00	3.84	25	----
150	18	20	11+	16	3.09	0.41	0.00	3.50	10.00	11	----
150	24	25	11+	16	2.91	0.36	0.02	3.29	7.69	13	----
150	30	25	11+	40	2.58	0.62	0.00	3.20	4.00	22	----
150	36	45	11+	16	2.50	0.35	0.10	2.95	2.22	50	----
150	52	55	11+	16					7.14	13	----
122	6	55	11+	40	5.24	0.11	0.00	5.35			
122	12	50	11+	21	0.96	0.38	0.27	1.61	2.33	49	----
122	18	35	11+	40	4.59	0.25	0.00	4.84	2.56	53	----
122	24	45	11+	16	5.39	0.08	0.00	5.47	2.94	34	----
122	30	50	11+	40	2.89	1.12	0.00	4.01	0.50	210	0.45
122	36	35	11+	16	3.48	1.18	0.30	4.96	2.08	52	----
122	52	25	11+	16	0.90	0.74	0.11	1.75	5.00	19	----
122	60	25	11+	16	1.22	0.33	0.18	1.73	1.00	20	----
122	66	25	11+	16	1.05	0.09	0.18	1.32	3.84	31	----
122	81	20	11+	16	1.05	0.05	0.12	1.22	7.69	14	----
PA Ambient	12	55	5.29	40	5.64	0.02	0.00	5.66	1.30	97	1.25
PA Ambient	24	55	5.52	40	5.76	0.02	0.00	5.78	1.05	135	1.00
PA Ambient	36	75	5.59	40	5.78	0.00	0.01	5.79	1.20	224	0.40
PA Ambient	48	75	6.66	40	5.65	0.07	0.00	5.72	1.16	105	1.13
PA Ambient	81	50	6.35	40	5.88	0.05	0.00	5.93	1.61	76	1.70
CZ Ambient	6	75	6.18	40	4.62	0.30	0.00	4.98			
CZ Ambient	12	75	6.02	40	4.62	0.03	0.00	4.65	1.45	101	1.45
CZ Ambient	18	55	11+	40	4.26	0.05	0.00	4.31	1.33	90	1.40
CZ Ambient	24	65	3.44	40	5.44	0.04	0.00	5.48			
CZ Ambient	30	75	5.19	40	4.91	0.12	0.00	5.03	1.56	115	1.45
CZ Ambient	36	60	7.68	40	5.09	0.03	0.00	5.12	1.58	81	1.80
CZ Ambient	42	60	7.06	40	5.85	0.06	0.00	5.91	1.41	143	1.00
CZ Ambient	52	70	7.78	40	6.08	0.01	0.00	6.09	1.67	59	1.50
CZ Ambient	57	60	6.59	40	5.45	0.05	0.00	5.50	1.50	74	1.30
CZ Ambient	64	75	8.48	40	4.81	0.12	0.00	4.93	1.66	68	2.05
CZ Ambient	70	90	8.11	40	5.41	0.09	0.01	5.51	1.85	110	2.00
CZ Ambient	79	50	7.65	40	5.72	0.05	0.00	5.77	2.00	56	----
CZ Ambient	85	65	9.19	40	5.92	0.03	0.00	5.95	2.17	52	----

TABLE XXI

Relative Viscosity of Aging Propellants After Ambient and Accelerated Storage

Manufacturer:	ALA	ALA	ALA	ALA	SUN	SUN	OKLA	OKLA	RAD	BAJ	RAD	HERC	RAD	RAD	RAD
Lot No.:	11225	31246	33716	33746	19243	19246	29220	29221	60326	37579	60578	39649	60310	60387	38145
Prop. Type:	M6	M6	M6	M6	M6	M6	IMR	IMR	M2	M6	M6	M9	M10	M15	T28
Storage Area	Storage Time, Mos.	Storage Temp., °C.													
PA	18	65.5	1.389	1.411	1.421	1.427	1.383	1.388			1.445	1.439		1.349	1.176	1.058
PA	24	65.5	1.362	1.407	1.386	1.384	1.364	1.377			1.408	1.404			1.127	1.045
PA	24	65.5[a]	1.361	1.399	1.376	1.390	1.367	1.380			1.403	1.398			1.134	1.044
PA	30	65.5	1.335	1.355	1.371	1.341	1.350	1.344			1.376	1.364			1.116	1.042
PA	18	50	1.611	1.668	1.665	1.651	1.656	1.648	1.868	1.829	1.507	1.805	1.848	1.592	1.728	1.546	1.379
PA	24	50	1.631	1.649	1.646	1.627	1.620	1.648	1.852	1.842	1.649	1.776	1.699	1.558	1.724	1.520	1.339
PA	24	50[a]	1.596	1.597	1.609	1.587	1.574	1.596	1.813	1.804	1.637	1.741	1.759	1.548	1.697	1.458	1.312
PA	30	50	1.584	1.596	1.612	1.626	1.587	1.598		1.805	1.670	1.765	1.780	1.561		1.478	1.285
PA	81	50	1.468	1.486	1.485	1.491	1.450	1.435				1.525	1.527		1.440	1.319	1.085
PA	24	Ambient	1.849	1.885	1.900	1.858	1.846	1.793	2.129	2.121	2.106	1.943	2.031	1.975	1.929	1.807	2.156
PA	24	Ambient[a]	1.753	1.817	1.837	1.799	1.798	1.759	2.057	2.055	2.047	1.922	2.022	1.853	1.908	1.704	2.007
PA	36	Ambient	1.857	1.865	1.909	1.876	1.826	1.802	2.104	2.106	1.979	1.917	1.988	1.926	1.901	1.802	2.140
PA	36	Ambient[a]	1.747	1.791	1.817	1.799	1.764	1.753	2.019	2.046	1.962	1.891	1.964	1.794	1.892	1.670	1.984
PA	48	Ambient	1.872	1.895	1.891	1.878	1.800	1.801	2.126	2.132							
PA	80	Ambient	1.790	1.838	1.857	1.821	1.757	1.841	2.093	2.096	2.056	1.916	1.933	1.896	1.894	1.750	2.067
CZ	24	Ambient	1.804	1.861	1.875	1.861	1.763	1.793	2.106	2.093	1.997	1.936	2.018	1.886	1.889	1.728	2.020
CZ	24	Ambient[a]	1.744	1.808	1.823	1.813	1.757	1.746	2.039	2.047	1.937	1.911	1.997	1.776	1.873	1.673	1.887
CZ	36	Ambient	1.833	1.853	1.865	1.854	1.786	1.767	2.064	2.058	1.932	1.930	1.913	1.840	1.860	1.696	1.960
CZ	36	Ambient[a]	1.734	1.802	1.828	1.816	1.737	1.705	2.023	2.030	1.928	1.875	1.856	1.742	1.843	1.636	1.863
CZ	42	Ambient	1.788	1.831	1.889	1.863	1.800	1.791	2.074	2.052	1.982	1.946	1.925	1.823	1.859	1.696	1.958
CZ	42	Ambient[a]	1.730	1.777	1.805	1.797	1.726	1.693	2.018	2.029	1.930	1.892	1.848	1.732	1.831	1.630	1.836
CZ	52	Ambient	1.802	1.851	1.885	1.872	1.790	1.790	2.018	2.029	1.920	1.937	1.965	1.800	1.846	1.670	1.930
CZ	79	Ambient	1.745	1.799	1.818	1.815	1.732	1.728		1.963	1.883	1.855	1.900	1.732	1.834	1.692	1.853
CZ	85	Ambient	1.772	1.810	1.840	1.817	1.772	1.730		2.013	1.845	1.869	1.959	1.731	1.814	1.643	1.827

[a] Storage at 80°C. for 2 additional days.

TABLE XXII

Quick Test Results of Propellant at Temperate and Tropical Storage

Storage Area	Storage Time, Mos.	Test Temp., °F.	Manufacturer: Lot No.:	ALA 11225	ALA 31246	ALA 33716	ALA 33746	SUN 19243	SUN 19246	OKLA 29220	OKLA 29221	RAD 60326	BAJ 37579	RAD 60578	HERC 39649	RAD 60310	RAD 60387	RAD 38145
Initial		80		5/6	0/1	6+	5	1	0/1	0/1	0/1	5	0	0	4	0	3/4	6+
CZ	6	Unknown		2/3	7	3	7	8	2	0	0	8	0	0	3	0	2	8
CZ	12	Unknown		2/3	7	2/3	8	8	2	0	0	8	0	0	8	0	2/3	8
CZ	24	90		1/2	1	1/2	2/3	5/6	5	0/1	0/1	6+	0	0	2/3	1/2	1/2	6
CZ	42	75		0/1	0/1	1	1	1/2	3/4	4	0/1	4/5	0	0	3/4	1/2	2	4
CZ	52	Unknown		1	0/1	2/3	2/3	2/3	3	3	3	7	0	0/1	2/3	3/4	1/2	3/4
CZ	58	Unknown		1/2	1/2	2	2	2/3	2/3	6	4/5	4/5	0	2	4	2	2/3	4
CZ	72	85.5		1	0/1	2/3	2/3	2/3	2/3		6	6	0	2/3	2/3	2/3	2	3/4
CZ	78	96		2	0/1	2/3	2/3	2/3	3		6+*	6+*	0+	3/4	3	2	2	4/5
PA	6	Unknown		3/4	1	2	2	0/1	0	0+	0+		0+	0			2	
PA	12	32		1/2	0	1	0/1	0/1	0	0	0	1/2	0	0	1/2	0	2	3/4
PA	18	67		3	1/2	3	2/3	1	0	0	0	5/6	0	0	1/2	0	2	3/4
PA	30	75		4	2	3	2/3	2	0/1	0/1	0/1	5	0	0	2	0	1/2	4/5
PA	36	43		1/2	0/1	1	1/2	0/1	0+	0+	0/1	2/3	0	0	1	0	1/2	2
PA	80	43		1/2	1/2	1/2	1/2	2	0/1	0	0	2/3	0	0	1/2	0	0/1	2/3

* Unwetted portion of Quick Test Paper turned yellow upon exposure to decomposition products of the propellant.

TABLE XXIII

Quick Test Results of Propellant Under 122°F. Storage at Aberdeen Proving Ground

Time, Mos.	Test Temp., °F.	IND-39734 A-1	IND-39734 A-2	IND-39734 A-3	ALA-11225 B-1	ALA-11225 B-2	ALA-11225 B-3	IND-BR-39744 C-1	IND-BR-39744 C-2	IND-BR-39744 C-3	RAD-RB-64012 D-1	RAD-RB-64012 D-2	RAD-RB-64012 D-3	PA-E-R-21406 E-1	PA-E-R-21406 E-2	PA-E-R-21406 E-3	OKLA-29250 F-1	OKLA-29250 F-2	OKLA-29250 F-3	OKLA-29220 G-1	OKLA-29220 G-2	OKLA-29220 G-3
6	90	0+	0+	0/1	8	8	8	0/1	0/1	0/1	7	--	3/4[b]	1	1	1	1	1/2	1/2	7	7	8[a]
8	80	--	0/1	--	2/3	--	--	--	--	0/1	--	3	--	--	--	1/2	2/3	--	--	6	6/7	--
11	70	0	0/1	0/1	1	2/3	2/3	0/1	0/1	0/1	6[a]	2/3	2/3	1	1	1	c	c	c	c	c	c
13	84	0/1	b	0/1	3	5	4	0/1		1	6+	3	5/6	2/3	b	6+						
16	101	0/1	0/1	0/1	3	3	5	2/3	2/3	1/2	6/7[a]	7	6/7	5	3/4	7						
20	71	0/1	0/1	0/1	2/3	3	2/3	0/1	0/1	1/2	5/6[a]	2/3	2/3	2/3	2/3	6/7[a]						
23	78	1	--	1	3	5	3	3	--	3	8	5/6	3/4	3/4	5	--[a]						
27	86	1/2	1/2	1	3	3	3	3	3	3	5/6[a]	5	4	4	4	--[d]						
8[e]-19	50																--[b]	0/1	2/3	6+[a]	6+[a]	1/2
32	76	2/3	2/3	1/2	3	4	4	3	--	3/4	2/3[a]	5	3/4	3/4	4/5							
39		7+	2/3	7	3	4	4	3	4	3	--[a]	f	3	3	3/4							
42		g	2/3	g	4	4/5	4/5	2/3	4/5	3/4			4	3	4/5							
47			2/3		2/3	3	2/3	2	4	2/3			2/3	3	4/5							
52			3/4		4/5	4	5	4	5	4			3/4	4/5								
39-13[e]	55	2/3																				
32-20[e]	55											2/3										
23-29[e]	55															2/3						
8-44[e]	55																		2/3			
55	63		3		2/3[b]	2/3[b]	3[b]	3	4	3			3	3	3/4							
58	73		3		4	4	4/5	3	4/5	4			3/4	3	4							
60	82		4		h	h	h	4	4/5	5			4/5	3/4	4/5							
61	82		4					4	4/5	5			4/5	3/4	4/5							
65	90		4					4/5	4/5	5			4	4/5	5							
66	81		5					4/5	5/6	4/5			4/5	5	4/5							
39-27[e]	43	3									3											
58-6[e]	42				2/3	2	1/2															
32-34[e]	46												2/3									
23-43[e]	47															3						
8-58[e]	51																		3/4			

a Unwetted portion of Quick Test Paper turned yellow upon exposure to decomposition products of the propellant.

b Quick Test Paper wet and end-point faded.

c Propellant - IMR removed to remote ambient storage area after 8 months at 122°F.

d Propellant - M6 removed to remote ambient storage area after 23 months at 122°F.

e Propellant tested in remote area (months at 122°F./months at ambient conditions).

f Propellant - M6 removed to remote ambient storage area after 32 months at 122°F.

g Propellant - M6 removed to remote ambient storage area after 39 months at 122°F.

h Propellant - M6 removed to remote ambient storage area after 58 months at 122°F.

TABLE XXIV

Quick Test Results of Propellant Under Desert Storage Conditions

Lot No.:		IND-39734		ALA-11225		IND-BR-39744		RAD-RB-64012		PA-E-R-21406		OKLA-29250		OKLA-29220	
Storage Site:		X-Site	Igloo	X-Site	Igloo	X-Site	Igloo	X-Site	Igloo	X-Site	Igloo	X-Site	Igloo	X-Site	Igloo
Time, Mos.	Test Temp., °F.														
6	--	0	0	1/2	1/2	1	1/2	2/3	1/2	0	0	1	0	1	0
12	--	0/1	0+	---[a]	4/5	2/3	6	8	8	1/2	1	2	5/6	1/2	1
22	79	0+	0	---[a]	1/2	2/3	2/3	2/3	2/3	0+	0+	0/1	0/1	1	0/1
27	82	0+	0	2	1/2	1/2	2/3	2/3	2/3	0+	0	0/1	0+	1/2	3
33	76	0	0	---[a]	1/2	3	2	2	2	0	0	2	1	2/3	3/4
39	86	0/1	1	1/2[a]	2/3	2/3	2	2/3	3	0/1	0/1	1	1	6+	6+
45	69	1/2	0/1	2[a]	1/2	0/1	1/2	2	2	0/1	0/1	0/1	0/1	3/4	6+
51	85	2	1/2	---[a]	1/2	1/2	1/2	2	1/2	0/1	0/1	5/6	1	6	6+
57	77	1/2	2/3	---[a]	0/1	1/2	0/1	1/2	1	0	0	5/6	0/1	6+	5/6
63	82	1/2	2/3	2[a]	2	1/2	1/2	1/2	1/2	1	1	1/2	1/2	6+	6+
69	69	1/2	2/3	1/2[a]	1/2	1/2	1/2	1/2	1/2	0+	0+	2	1/2	--	--
75	77	2	3	2[a]	1	1	2	2	2/3	0/1	0/1	2/3	2/3	--	--
81	72	1/2	2	2[a]	1	1/2	1/2	2/3	1/2	0/1	0/1	2/3	2	--	--

[a] Test paper wet at conclusion of test, occasionally masking end-point.

TABLE XXV

Surveillance Data, Days to Red Fumes at 65.5°C.

Lot No.	Storage Area	Initial	Storage Time, Months										
			6	12	18	24	30	36	42	48	52	57	64
ALA-11225	Picatinny	1515		1474		1576							
ALA-11225	Canal Zone		1470	1353	1400	1344	1370	1366					
ALA-31246	Picatinny	1623		1603		1605							
ALA-31246	Canal Zone		1755	1600	1546	1561							
ALA-33716	Picatinny	1647		1702		1630							
ALA-33716	Canal Zone		1917	1768	1763	1612							
ALA-33746	Picatinny	1404		1354		1502							
ALA-33746	Canal Zone		1469	1459	1425	1363	1357						
SUM-19243	Picatinny	1631		1624		1605							
SUM-19243	Canal Zone		1733	1578	1678	1564							
SUM-19246	Picatinny	1890		1471		1619							
SUM-19246	Canal Zone		1785	1613	1706	1590							
OKLA-29220	Picatinny	244		307		204		263		310			
OKLA-29220	Canal Zone		309	192	291	157	276	382	40		18	10	
OKLA-29221	Picatinny	249		355		185		263		278			
OKLA-29221	Canal Zone		329	203	243	164	201	214	257		102	112	78
RAD-60326	Picatinny	426		459		414		467		424			
RAD-60326	Canal Zone		533	421	340	391	502	446	363		347	146	415
BAJ-37579	Picatinny	2029		1866									
BAJ-37579	Canal Zone		2133	2009									
RAD-60578	Picatinny	2033		2084									
RAD-60578	Canal Zone		2137	1968									
HERC-39649	Picatinny	257		320		259		390		364			
HERC-39649	Canal Zone		326	378	322	192	334	202	313		278	220	287
RAD-60310	Picatinny	709		334		663		757		761			
RAD-60310	Canal Zone		738	609	598	593	577	551	539		469	488	

TABLE XXV (CONT)

Surveillance Data, Days to Red Fumes at 65.5°C.

Lot No.	Storage Area	Initial	Storage Time, Months						
			6	12	22	30	34	51	63
IND-39734	YPG-Igloo	2076	2023						
IND-39744	YPG X-Site		2028						
ALA-11225	YPG Igloo	1551	1383	1505	1508				
ALA-11225	YPG X-Site		1498	1535	1562				
IND-BR-39744	YPG Igloo	1662	1632	1708	1475				
IND-BR-39744	YPG X-Site		1601	1442	1515		1324		
RAD-RB-64012	YPG Igloo	1460	1657	1758	1581				
RAD-RB-64012	YPG X-Site		1606	1662	1226				
PA-E-R-21406	YPG Igloo		2134						
PA-E-R-21406	YPG X-Site								
OKLA-29250	YPG Igloo		354	335	328	421	419		282
OKLA-29250	YPG X-Site		364	325	346	397	372	364	302
OKLA-29220	YPG Igloo	263	230	287	197	222	334	58	5
OKLA-29220	YPG X-Site		272	304	304	379	317	313	68

TABLE XXVI

Safe Life Data on .30 and .50 Caliber IMR Propellant

Propellant Lot No.	Available Stabilizer, %	IMR Prop. Type	65.5°C. Surveillance Test Data, Days to Red Fumes															Storage Life, Years
			Test #1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	
ALA-4619-42	0.25	4814	365+	506	600	506	118	93	25	26	20								13
ALA-4621-42	0.49	4814	365+	630	556	463	116	111	42	26	19								12
ALA-X4302-42	0.05	4676	365+	558	602	505	407	119	125	17									12
OKLA-21220-43	0.24	4861	365+	543	519	199	275	42	30	93	43	22	21	18					11
OKLA-21233-43	0.22	4861	365+	575	505	207	399	20											11
OKLA-21265-43	0.23	4861	365+	363	90	25	29	30	25	28	86	17							8
OKLA-21276-43	0.21	4861	365+	553	467	302	27	19	13										9
OKLA-21448-43	0.02	4895	365+	644	495	413	20												11
ALA-2436-44	0.26	4895	365+	494	422	54	36	37	29	36	30	75	14						10
ALA-2443-44	0.20	4895	365+	502	500	23	41	42	27	15	14								12
ALA-2444-44	0.23	4895	365+	513	366	266	81	5	16										10
ALA-2469-44	0.48	4895	365+	47	80	24	24	22	23	33	23	29	55	23	22	27	18		7
ALA-2487-44	0.49	4895	365+	511	589	29	22	27	63	55	57	20							11
ALA-2723-44	0.13	4895	365+	464	343	20	20												8
ALA-2762-44	0.25	4895	365+	44	347	25	20												7
ALA-2766-44	0.37	4895	365+	377	18														7
ALA-2767-44	0.08	4895	365+	19															6
ALA-R-71-44	0.32	5065	365+	675	791	20	20												11
OKLA-29221-45	0.18	5010	365+	443	505	335	11												10
OKLA-29229-45	0.10	5010	365+	418	419	293	15	16											10
OKLA-29230-45	0.38	5010	365+	409	429	429	20												10

TABLE XXVI (Cont)

Safe Life Data on .30 and .50 Caliber IMR Propellant

Propellant Lot No.	Available Stabilizer, %	IMR Prop. Type	65.5°C. Surveillance Test Data, Days to Red Fumes															Storage Life, Years
			Test #1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	
OKLA-29240-45	0.31	5010	365+	408	329	30	84	31	30	26	30	27	25	26	61	20			8
OKLA-29243-45	0.35	5010	365+	385	325	87	25	29	24	29	23	54	66	35	22	21	57	20	8
OKLA-29250-45	0.17	5010	365+	413	373	327	15	16											10
OKLA-29271-45	0.37	5010	365+	443	519	471	20												10
DPCP-28037-45	0.20	5010	285	348	353	364	298	303	342	356	434	16	12						10
ALA-R-127-45	0.12	5065	365+	681	602	15	15												10
ALA-R-128-45	0.13	5065	365+	691	693	18													10
ALA-R-129-45	0.10	5065	365+	707	576	15	16												10
ALA-R-130-45	0.12	5065	365+	710	692	15													10
ALA-R-133-45	0.07	5065	365+	630	550	5													10
ALA-R-135-45	0.11	5065	365+	608	9														10
ALA-R-136-45	0.14	5065	365+	646	563	12	14												10
ALA-R-137-45	0.20	5065	365+	641	614	20													10
ALA-R-140-45	0.08	5065	365+	620	535	5													10
ALA-R-142-45	0.06	5065	365+	621	543	8													10
ALA-R-143-45	0.08	5065	365+	551	540	5	8												10
ALA-R-144-45	0.16	5065	365+	353	583	7	8												10
ALA-R-146-45	0.08	5065	365+	431	19	22	20	7											6
ALA-R-147-45	0.13	5065	365+	557	536	12	14												10
ALA-R-151-45	0.11	5065	365+	594	9														10
ALA-R-163-45	0.11	5065	365+	515	537	15													8

NOTE: 1. Days (365+) is value of initial test. Subsequent values represent continuous testing (repeat test at end-point) after 5 years from initial test.

2. Available stabilizer (DPA) analysis according to gravimetric bromination method MIL-STD-286A, paragraph 201.2.3.

3. The ALA-R- propellant type 5065 did not have potassium sulfate added.

TABLE XXVII

Propellant Mass Temperature Data on IMR Lot No. OKLA-29220-45

Time, Hours	Date:	Temperature, °F.									
		9 July		10 July		11 July		12 July		13 July	
	Box No. :[a]	G-2-I	G-2-X	G-2-I	G-2-X	G-2-I	G-2-X	G-2-I	G-2-X	G-2-I	G-2-X
0100		121	114	125	110	130	107	133	105	148	113
0200		122	111	125	108	131	105	134	104	150	111
0300		122	110	125	107	131	104	134	101	152	109
0400		122	109	125	105	131	102	134	100	154	107
0500		122	108	125	104	130	100	134	98	156[b]	105
0600		122	107	125	103	130	99	133	97	---	105
0700		122	107	123	104	129	101	132	99	---	106
0800		121	108	122	108	128	105	131	105	---	111
0900		120	110	121	113	128	110	130	113	---	116
1000		122	117	121	119	127	112	130	116	---	121
1100		119	118	122	122	126	117	130	123	---	126
1200		120	120	123	124	126	121	130	126	---	129
1300		121	122	124	126	126	125	130	129	---	132
1400		121	125	124	126	128	127	131	131	---	134
1500		121	127	124	129	129	129	134	134	---	134
1600		122	130	125	129	129	129	135	135	---	137
1700		123	130	126	130	130	130	136	136	---	135
1800		123	129	126	128	130	128	136	136	---	135
1900		124	126	127	126	130	127	137	132	---	132
2000		124	123	127	122	131	124	139	128	---	129
2100		124	121	128	119	131	118	140	124	---	125
2200		124	119	129	116	132	114	142	120	---	121
2300		125	115	130	113	133	111	144	117	---	119
2400		125	112	130	110	133	108	146	115	---	116

[a] Box No. G-2-I previously stored 63 months at igloo conditions; Box No. G-2-X previously stored 63 months at surface X-Site conditions.
[b] Proceeded to ignition.

APPENDIX B

FIGURES I, II, AND III

FIGURE 1

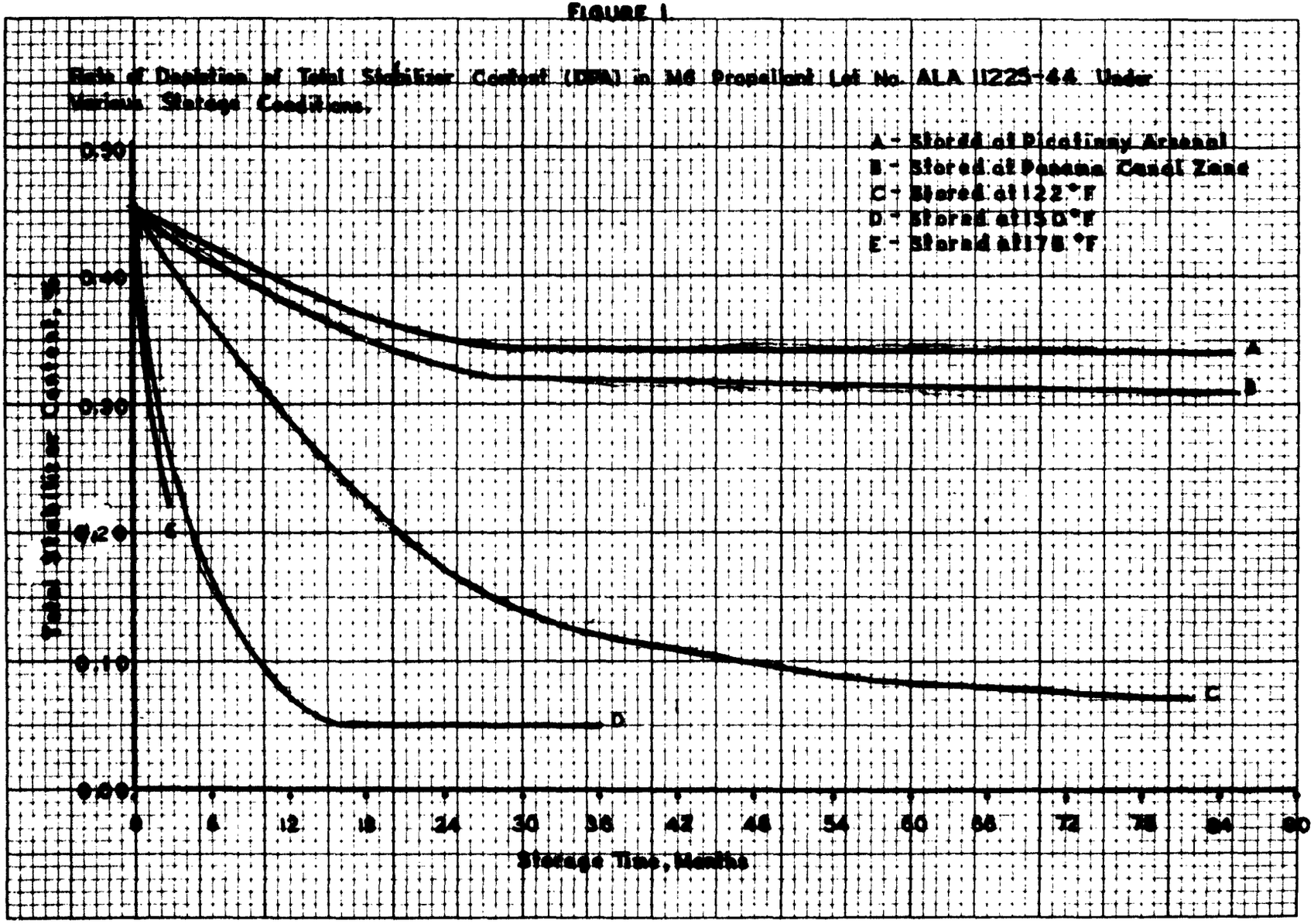

Rate of Depletion of Total Stabilizer Content (DPA) in M6 Propellant Lot No. ALA 11225-44 Under Various Storage Conditions.
A - Stored at Picatinny Arsenal
B - Stored at Panama Canal Zone
C - Stored at 122°F
D - Stored at 150°F
E - Stored at 178°F
0.90
0.80
0.30
0.20
0.10
0.00
Storage Time, Months

FIGURE 2

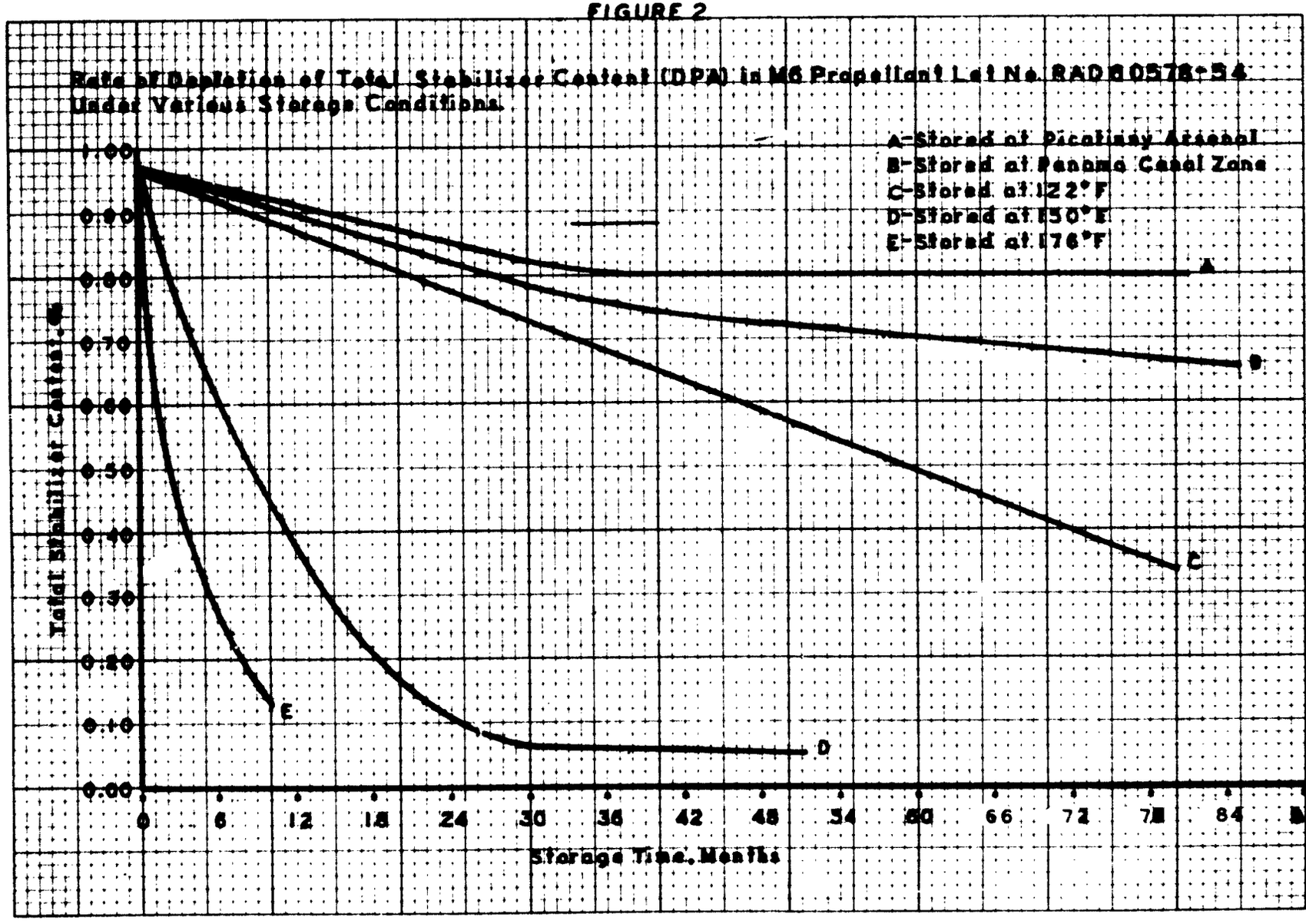
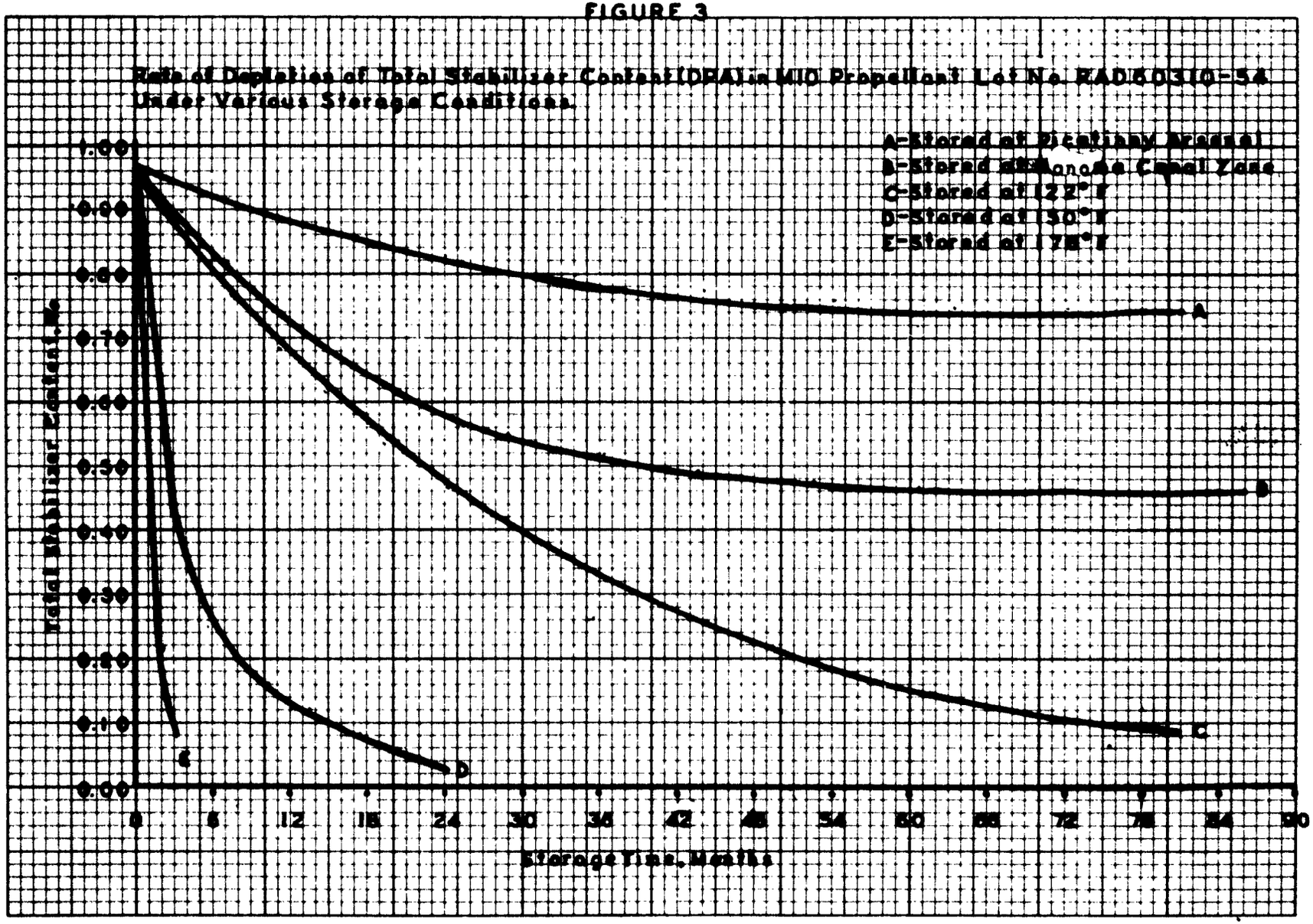

Rate of Depletion of Total Stabilizer Content (DPA) in M6 Propellant Lot No. RAD 60578-54
Under Various Storage Conditions.
A-Stored at Picatinny Arsenal
B-Stored at Panama Canal Zone
C-Stored at 122°F
D-Stored at 150°F
E-Stored at 176°F
Total Stabilizer Content, %
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
Storage Time, Months
A
B
C
D
E

FIGURE 3


Rate of Depletion of Total Stabilizer Content (DPA) in MIO Propellant Lot No. RAD 60310-54 Under Various Storage Conditions.
A-Stored at Picatinny Arsenal
B-Stored at Panama Canal Zone
C-Stored at 122° F
D-Stored at 150° F
E-Stored at 178° F
Total Stabilizer Content, %
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
Storage Time, Months
A
B
C
D
E

APPENDIX C

PROPELLANT DESCRIPTION SHEETS OF THE FORMULATIONS INVOLVED IN THIS PROGRAM

SMOKELESS POWDER DESCRIPTION SHEET 07-283-D4-CC

U.S. Army Lot No. 11,225 of 1944 NH, III, for 155 mm Gun, M1
Packed Weight 134,970 lbs. Mfg. at Alabama Ordnance Works, Sylacauga, Alabama.
Contract No. W-ORD-497 Date 1-22-41 Specification No. 50-12-3B Revision Rev 3A

NITROCELLULOSE

Accepted blends (Nos.) 1244, 1245, 1246, 1247, 1248, 1249
Woodpulp Nitrocellulose

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.16	Maximum	45+'	Maximum	30'
Minimum	13.13	Minimum	35'	Minimum	30'
Average	13.14	Average	38'	Average	30'

MANUFACTURE OF POWDER

Total weight of solvent per pound ingredients 0.592 Consisting of 32 pounds alcohol and 68 pounds ether per 100 pounds solvent. Percentage of remix to whole 3.6

TEMPS., °C. From	TEMPS., °C. To	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES Days	TIMES Hours
30	65	Solvent Recovery (Start at 30°C., 30°C. to 65°C. = 18 hours 65°C. = 44 hours)		62
65	65	Water dried { constant		120
55	55	Air dried { temperature		16

TESTS OF FINISHED POWDER

COMPOSITION Constituent	Formula	Mfr.	Inspr.	STABILITY AND PHYSICAL TESTS	Mfr.	Inspr.
Nitrocellulose	87.00	85.82		135° C. test, S. P.	60'	
DNT and DBP	13.00	13.18		Explosion (hrs.)	5+	
(DNT - 10%)				Form of grain	Cyl.	
(DBP - 3%)				No. of perforations	7	
				No. of grains per pound		
Diphenylamine	1.08	1.00		Burning surface per lb. (sq. in.)		
Volatile Solvents		1.56		Specific gravity		
Moisture		.41		Hygroscopicity		
Ash				Compression test	325	

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Inspector
Length (L)	.8000	.7859			
Diameter (D)	.4500	.3196			
Diameter of perforations (d)	.0440	.0306			
Web Inner	.0835	.0576			
Web Outer	.0755	.0563			
Web Average	.0795	.0570			
Difference between inner and outer web in per cent of web average		- 2.3			
L:D (Y)					
D:d (X)					

Date packed 3-17-44 Date offered 3-17-44 Date sampled 3-17-44
Date test finished 3-27-44 Date description sheets forwarded

Remarks: Packed in reconditioned metal Navy boxes - Mark VII. This lot meets chemical and physical acceptance requirements.

J. V. LE MAISTRE, Capt., Ord. Dept. U.S. Army
Army Inspector of Ordnance

R. F. BOLTZ/Manager
djc

H. M. DUNHAM

H. M. DUNHAM

SMOKELESS POWDER DESCRIPTION SHEET 07-283-IM-CC

U.S. Army Lot No. 31,2_ of 1944 M1, M1 for 155 MM Gun, 11

Packed Weight 139,370 lbs. Mfg. at Alabama Ordnance Works, Sylacauga, Alabama.

Contract No. W-ORD-477 Date 1-22-41 Specification No. 50-12-3B Revision R-3A

NITROCELLULOSE

Accepted blends (Nos.) 1865, 1866, 1869, 1870, 1871, 1872, 1873

Woodpulp Nitrocellulose

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.15	Maximum	39'	Maximum	30'
Minimum	13.13	Minimum	36'	Minimum	30'
Average	13.14	Average	38'	Average	30'

MANUFACTURE OF POWDER

Total weight of solvent per pound ingredients 0.592 Consisting of 32 pounds alcohol and 68 pounds ether per 100 pounds solvent. Percentage of remix to whole 4.1

TEMPS., °C. From	To	PROCESS—SOLVENT RECOVERY AND DRYING		TIMES Days	Hours
30	65	Solvent Recovery (Start at 30°C. - 30°C. to 65°C. - 5 hours 65°C. - 57 hours)			62
65	65	Water dried	constant		120
55	55	Air dried	temperature		20

TESTS OF FINISHED POWDER

COMPOSITION Constituent	Formula	Mfr.	Inspr.	STABILITY AND PHYSICAL TESTS	Mfr.	Inspr.
Nitrocellulose	87.00	85.10		135° C. heat test, S. P.	65'	
DNT and DBP	13.00	13.83		Explosion (hrs.)	5+	
(DNT = 10%)				Form of grain	Cyl.	
(DBP = 3%)				No. of perforations	7	
				No. of grains per pound		
Diphenylamine	1.08	1.07		Burning surface per lb. (sq. in.)		
Volatile Solvents		1.10		Specific gravity		
Moisture		.61		Hygroscopicity		
Ash				Compression test	44%	

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	Inspector
Length (L)	.7800	.7646			
Diameter (D)	.4450	.3150			
Diameter of perforations (d)	.0440	.0315			
Web Inner	.0815	.0538			
Web Outer	.0750	.0564			
Web Average	.0783	.0551			
Difference between inner and outer web in per cent of web average		+ 4.7			
L:D (Y)					
D:d (X)					

Date packed 10-1-44 Date offered 10-12-44 Date sampled 10-2-44

Date test finished 10-10-44 Date description sheets forwarded

Remarks: Packed in reconditioned metal Navy boxes - Mark VII. This lot meets chemical and physical acceptance requirements.

R. F. BOLTZ/ Manager

J. W. LE MAISTRE, Capt., Ord. Dept.
Army Inspector of Ordnance. U.S. Chemist.

dje

H. M. Dunham
H. M. DUNHAM

SMOKELESS POWDER DESCRIPTION SHEET

U.S. Army Lot No. 33,716 of 1945 Ni. M for 155 MM Gun, M1

Packed Weight 133,430 lbs. Mfg. at Alabama Ordnance Works, Sylacauga, Alabama.

Contract No. W-ORD-526, Dated 6-30-41 Specification No. 50-12-38 Addendum R-38

NITROCELLULOSE

Accepted blends (Nos.) 1632, 1637, 1638, 1639, 1640, 1643

Woodpulp Nitrocellulose

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.15	Maximum	42'	Maximum	30'
Minimum	13.13	Minimum	36'	Minimum	30'
Average	13.14	Average	39'	Average	30'

MANUFACTURE OF POWDER

Total weight of solvent per pound ingredients 0.626 Consisting of 35 pounds alcohol and 65 pounds ether per 100 pounds solvent. Percentage of remix to whole 5.2

TEMPS. °C. From	TEMPS. °C. To	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES Days	TIMES Hours
30	65	Solvent Recovery (Start at 30°C., 30°C. to 65°C. = 5 hours, 65°C. = 57 hours)		62
65	65	Water dried — constant temperature		108
55	55	Air dried — constant temperature		35

TESTS OF FINISHED POWDER

COMPOSITION

Constituent	Formula	Mfr.	Inspr.
Nitrocellulose	87.00	85.78	
DNT and DBP	13.00	13.17	
(DNT 10%)			
(DBP 3%)			
Diphenylamine	1.05	1.05	
Volatile Solvents		1.55	
Moisture		.51	
Ash			

STABILITY AND PHYSICAL TESTS

	Mfr.	Inspr.
135° C. heat test, S. P.	60'	
Explosion (hrs.)	5+	
Form of grain	Cyl.	
No. of perforations	7	
No. of grains per pound		
Burning surface per lb. (sq. in.)		
Specific gravity		
Hygroscopicity		
Compression test	39"	

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Inspector
Length (L)	.7800	.7603			
Diameter (D)	.4500	.3205			
Diameter of perforations (d)	.0440	.0319			
Web — Inner	.0835	.0562			
Web — Outer	.0755	.0562			
Web — Average	.0795	.0562			
Web relation A-Type 1		6.0			
Web relation B-Type 2					
D (Y)					
d (X)					

Date packed 6-6-45 Date offered 6-13-45 Date sampled 6-6-45

Date test finished 6-13-45 Date description sheets forwarded JUN 20 1945

Remarks: Packed in reconditioned metal Army boxes - M2. This lot meets chemical and physical acceptance requirements.

R. F. BOLTZ/ Manager J. P. Hollis J. P. HOLLIS Toch. Supt.

owg

H. R. PFESTERA, Army Inspector of Ordnance, Chief Civilian Inspector U.S. Chemist

SMOKELESS POWDER DESCRIPTION SHEET

U.S. Army Lot No. 33-746 of 1945 NH, M1 for 155 MM Gun, M1
Packed Weight 152,680 lbs. Mfg. at Alabama Ordnance Works, Sylacauga, Alabama.
Contract No. W-ORD-526, Dated 6-30-41 Specification No. 50-12-3B Addendum R-3B

NITROCELLULOSE

Accepted blends (Nos.) 2100; 2101; 2102; 2103; 2104. Woodpulp Nitrocellulose.
*Returned Increment powder from Coosa River Ord. Plant by Sidney Smith truck, 29 June 45.

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.16	Maximum	42'	Maximum	30'
Minimum	13.13	Minimum	37'	Minimum	30'
Average	13.14	Average	39'	Average	30'

MANUFACTURE OF POWDER

Total weight of solvent per pound ingredients 0.609 Consisting of 35 pounds alcohol and 65 pounds ether per 100 pounds solvent. Percentage of remix to whole 4.2

TEMPS. °C. From	TEMPS. °C. To	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES Days	TIMES Hours
30	65	Solvent Recovery (Start at 30°C., 30°C., to 65°C.		
		5 hours 65°C. - 85 hours)		90
65	65	Water dried { constant		120
55	55	Air dried { temperature		18

TESTS OF FINISHED POWDER

COMPOSITION Constituent	Formula	Mfr.	Insp.	STABILITY AND PHYSICAL TESTS	Mfr.	Insp.
Nitrocellulose	87.00	85.24				
DNT and DBP	13.00	13.78		135° C. heat test, S. P.	65'	
(DNT - 10%)				Explosion (hrs.)	5+	
(DBP - 3%)				Form of grain	Cyl.	
				No. of perforations	7	
Diphenylamine	1.03	.98		No. of grains per pound		
Volatile Solvents		1.34		Burning surface per lb. (sq. in.)		
Moisture		.5%		Specific gravity		
Ash				Hygroscopicity		
				Compression test	38%	

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Inspector
Length (L)	.7600	.7419			
Diameter (D)	.4400	.3219			
Diameter of perforations (d)	.0440	.0323			
Web Inner	.0815	.0558			
Web Outer	.0725	.0567			
Web Average	.0770	.0563			
Web relation A-Type 1		1.6			
Web relation B-Type 2					
L:D (Y)					
D:d (X)					

Date packed 8-28-45 Date offered 9-5-45 Date sampled 8-29-45
Date test finished 9-5-45 Date description sheets forwarded SEP 1 1945
Remarks: Packed in New Metal Army Boxes M2. This lot meets chemical & physical acceptance requirements. ◆ Contains 120 lbs. of returned powder.

R. F. BOLTZ/ Manager J. P. Hollis J. P. HOLLIS Tech. Supt.
M. R. Prestera M. R. PRESTERA, Chief Civilian Inspector
Army Inspector of Ordnance. U.S. Chemist.

mob

RESTRICTED

POWDER DESCRIPTION SHEET

NH 11 for 155 MM Gun M1

Sun

U. S. ARMY LOT NO. 19263 OF 1945 MFR. LOT NO. ____ TYPE 1 FOR ____ MODEL OF ____

Packed weight 150,150 lbs. Manufactured by Hercules Powder Company, Sunflower Ordnance Works, Lawrence, Kansas. Amend 75

TRACT NO. W-ORD-633 DATE 11 May 42 SPECIFICATION NO. 50-12-3x [illegible] 2 Feb 1945

NITROCELLULOSE IS 260, Rev. 2, 8 Jun 1943

ACCEPTED FURNISH (NOW) Wood Pulp

B-10457Y, B-10458Y, B-10459Y, B10460Y, B10461Y

NITROGEN CONTENT		K. I. STARCH TEST (65.5° C.)		STABILITY TEST (115° C.)	
MAXIMUM	13.14	MAXIMUM	45'	MAXIMUM	30'
MINIMUM	13.11	MINIMUM	45'	MINIMUM	30'
AVERAGE	13.12	AVERAGE	45'	AVERAGE	30'
				EXPLOSION	

MANUFACTURE OF POWDER

Powder

TOTAL WEIGHT OF SOLVENT PER POUND OF 0.60 CONSISTING OF 36.0 POUNDS ALCOHOL AND 64.0 POUNDS ETHER PER 100 POUND SOLVENT. PERCENTAGE OF REMIX TO WHOLE 0.4

TEMPS., °C. FROM	TEMPS., °C. TO	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES DAYS	TIMES HOURS
40	40	Solvent Recovery (Loading)		
40	40	Solvent Recovery		15
65	65	Solvent Recovery	1	21
55	55	Water Dry	8	
55	55	Air Dry		12

TESTS OF FINISHED POWDER

COMPOSITION — CONSTITUENT	FORMULA	MFR.	INSPR.
Nitrocellulose	85.90		85.83
DNT + DBP	13.00		13.27
(DNT - 10%)			
(DBP- 3%)			
DIPHENYLAMINE			0.90
TOTAL VOLATILES (Solvents)			1.05
MOISTURE			0.58
ASH			

STABILITY AND PHYSICAL TESTS	MFR.	INSPR.
135° C HEAT TEST, E. P.		65'
EXPLOS. ON		5 hrs.+
FORM OF GRAIN		Cyl.
NO. OF PERFORATIONS		7
NO. OF GRAINS PER POUND		
BURNING SURFACE PER POUND (SQ. INCHES)		
GRAV. DENSITY, OR POUNDS PER CU. FT.		
SPECIFIC GRAVITY		
HYGROSCOPICITY		
COMPRESSION TEST		36.3

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) MANUFACTURER	FINISHED GRAIN (INCHES) INSPECTOR	MEAN VARIATION IN PER CENT OF MEAN DIMENSION MANUFACTURER	MEAN VARIATION IN PER CENT OF MEAN DIMENSION INSPECTOR
LENGTH (L)	0.723		0.7044	1.3% of 1000 grains	
DIAMETER (D)	0.425		0.2990	from chemical sample	
DIAMETER OF PERFORATIONS (d)	0.037		0.0259	consists of cracked,	
WEB — INNER	0.081		0.0532	broken, & short grain	
WEB — OUTER	0.076		0.0575	and grains with 6 or	
WEB — AVERAGE	0.079		0.0554	less perforations.	
WEB — CALCULATED			0.0554		
DIFFERENCE BETWEEN INNER AND OUTER WEB IN PER CENT OF WEB AVERAGE			7.76		
L/D (Y)					
D/d (X)					

DATE PACKED 19 Mar 45 DATE OFFERED 19 Mar 45 DATE SAMPLED 19 Mar 45

DATE TEST FINISHED 26 Mar 45 DATE DESCRIPTION SHEETS FORWARDED 5 April 1945

REMARKS Packed in galvanized cans. Manufactured with Macaroni Press. This lot meets chemical and physical requirements. Ord. Dept. responsible for Inspection data only.

J. M. Martin
Opr. Mgr.
J. M. Martin

W. C. Rotenberry
INSPECTOR OF ORDNANCE
W. C. Rotenberry, 1st Lt., Ord.

J. C. Horvath
U. S. CHEMIST
J. C. Horvath

O. O. FORM NO. 5336

[illegible] POWDER DESCRIPTION SHEET

M1,M1 for 155 MM Gun M1

U. S. ARMY LOT NO. Sun 19246 OF 1945 MFR. LOT NO. ______ TYPE 1 FOR ______ MODEL OF ______

Packed weight 150,150 lbs. Manufactured by Hercules Powder Company, Sunflower Ordnance Works, Lawrence, Kansas. Amend #5

CONTRACT NO. [illegible]2637 DATE 11 May 42 SPECIFICATION NO. 50-12-3 REVISION OF 2 Feb 45

NITROCELLULOSE [illegible] 260, Rev.2, 8 Aug 43

Wood Pulp

ACCEPTED BLENDS (NOS.) B-10538Y, B-10539Y, B-10540Y, B-10541Y, B-10542Y, B-10544Y

NITROGEN CONTENT		K. I. STARCH TEST (65.5° C.)		STABILITY TEST (135° C.)	
MAXIMUM	13.16	MAXIMUM	45'	MAXIMUM	35'
MINIMUM	13.11	MINIMUM	45'	MINIMUM	30'
AVERAGE	13.13	AVERAGE	45'	AVERAGE	33'
				EXPLOSION	

MANUFACTURE OF POWDER

TOTAL WEIGHT OF SOLVENT PER POUND powder 0.60 CONSISTING OF 36.0 POUNDS ALCOHOL AND 64.0 POUNDS ETHER PER 100 POUND SOLVENT. PERCENTAGE OF REMIX TO WHOLE 8.9

TEMPS., °C. FROM	TO	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES DAYS	HOURS
40	40	Solvent Recovery (Loading)		
40	40	Solvent Recovery		15
65	65	Solvent Recovery	1	21
55	55	Water Dry	8	
55	55	Air Dry		12

TESTS OF FINISHED POWDER

COMPOSITION CONSTITUENT	FORMULA	MFR.	INSPR.
Nitrocellulose	86.00		85.81
DNT & DBP	13.00		13.25
(DNT - 10%)			
(DBP - 3%)			
DIPHENYLAMINE	1.00		0.94
TOTAL VOLATILES / Solvents			1.50
MOISTURE			0.60
ASH			

STABILITY AND PHYSICAL TESTS	MFR.	INSPR.
135° C HEAT TEST, S. P.		60'
EXPLOSION		5 hrs.+
FORM OF GRAIN		Cyl.
NO. OF PERFORATIONS		7
NO. OF GRAINS PER POUND		
BURNING SURFACE PER POUND (SQ. INCHES)		
GRAV. DENSITY, OR POUNDS PER CU. FT.		
SPECIFIC GRAVITY		
HYGROSCOPICITY		
COMPRESSION TEST		36.5

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) MANUFACTURER	INSPECTOR	MEAN VARIATION IN PER CENT OF MEAN DIMENSION MANUFACTURER	INSPECTOR
LENGTH (L)	0.723		0.7038		
DIAMETER (D)	0.425		0.3022	0.2% chemical sam-	
DIAMETER OF PERFORATIONS (d)	0.037		0.0264	ple consists of short	
WEB INNER	0.081		0.0542	grs.	
WEB OUTER	0.076		0.0574		
WEB AVERAGE	0.079		0.0558		
WEB CALCULATED			0.0558		
DIFFERENCE BETWEEN INNER AND OUTER WEB IN PER CENT OF WEB AVERAGE			5.73		
L/D (Y)					
D/d (X)					

DATE PACKED 10 April 45 DATE OFFERED 10 April 45 DATE SAMPLED 10 April 45

DATE TEST FINISHED 10 April 45 DATE DESCRIPTION SHEETS FORWARDED 20 April 45

REMARKS: Packed in galvanized steel cans. Manufactured with Macaroni Press. This lot meets chemical and physical requirements. Ord. Dept. responsible for Inspection data only.

J. M. Martin — Opr. Mgr. — J. L. Martin

W. C. Rotenberry — INSPECTOR OF ORDNANCE — W. C. Rotenberry, 1st Lt., O.D.

J. C. Horvath — U. S. CHEMIST — J. C. Horvath

OD FORM 1204 15 Apr. 52 RAD	ORDNANCE CORPS PROPELLANT DESCRIPTION SHEET	Supersedes OD Form 1204 dated 1 Jul. 49 which is obsolete.

U.S. Army Lot No. 60578 of [illegible] Correction No. [illegible] For 280 [illegible]
Gun, T131 W/CHG. T44
Manufactured at: Radford Arsenal, Radford, Va.
Contract No. W-11-173- Date 28 April 1949 Specification No. [illegible] Revision of dated 22 March
ORD-37 NITROCELLULOSE 270 1926
Accepted blends (Nos.) C 13,544-546-547-548-550-554-556-557-559-563

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.17 %	Maximum	45 + Mins.	Maximum	30 Mins.
Minimum	13.13 %	Minimum	45 + Mins.	Minimum	30 Mins.
Average	13.15 %	Average	45 + Mins.	Average	30 Mins.
				Explosion	Mins.

MANUFACTURE OF PROPELLANT

dry ingredient
Total weight of solvent per pound NC 62 Consisting of 35 pounds alcohol and 65 pounds ether per 100 pound solvent. Percentage of remix to whole 10%

Temps. °C From	To	Process—Solvent Recovery and Drying	Time Days	Hours
	35	Solvent Recovery		Load
35	50	Solvent Recovery		8
50	55	Solvent Recovery		72
65	65	Water Dry	12	
55	55	Air Dry		40-45

TESTS OF FINISHED PROPELLANT

Composition Constituent	Formula	Spec. Tol.	Mfr. Insp.
Nitrocellulose	87.0	± 2.0	87.18
Dinitrotoluene	10.0	± 2.0	10.02
Dibutylphthalate	3.0	± 1.0	2.80
Residual Solvent	2.60	max	2.22
Diphenylamine	1.0	± .10	1.02
Total volatiles			2.72
Moisture	0.60	± 0.20	0.50
Ash	0.40	max	0.07

Stability and Physical Tests	Mfr.	Insp.
134.5 C heat test, S.P.	45	
Explosion	5 hrs	
Form of grain	cyld	
No. of perforations	7	
No. of grains per pound		
Burning surface per pound (sq. inches)		
Grav. density, or pounds per cu. ft.		
Specific gravity		
Hygroscopicity		
Compression test	41.92	

Grain Dimensions	Die (Inches)	Finished Grain (Inches) Manufacturer	Inspector	Mean Variation in Per Cent of Mean Dimension Manufacturer	Inspector
Length (L)	1.57 ± .02	1.513		0.46	
Diameter (D)	.875	0.6189		1.29	
Diameter of perforations (d)	.098	0.0726			
Web Inner	.1525	0.1020			
Web Outer	.1380	0.0986			
Web Average	.1452	0.1003			
Web Calculated					
Difference between inner and outer web in per cent of web average		3.39			
L÷D (Y)		2.44			
D÷d (X)		8.52			

Date packed 11/? /54 Date offered 20 Dec. 1954 Date sampled 12-?-54
Date test finished 12-16-54 Date description sheets forwarded DEC 30 1954
Type of Packing Box Mark #2
Remarks: This lot meets chemical and physical requirements.

Assistant Technical Superintendent	Army Inspector of Ordnance	
H.R.Davies (signature)	M.C.Willard (signature)	by James W. [illegible] (signature)

OD FORM 15 Apr. 52 1204	ORDNANCE CORPS **PROPELLANT DESCRIPTION SHEET**	Supersedes OD Form 1204 dated 1 Jul. 49 which is obsolete.

U.S. Army Lot No. BAJ-37579 at 1955 Composition No. M6 For 76mm Gun T91 with Cartridge T124, T140E2 (Code 19210)

Manufactured at: Liberty Powder Defense Corp., Badger Ordnance Works Accept. Weight 450,098 lbs.

Contract No. DA-11-173-ORD-106 Date 30 Apr 1951 Specification No. JAN-P-309 Revision of 28 March 1946

NITROCELLULOSE

Accepted blends (Nos.) (Pulp) B-10245, -47, -51 thru -63

Nitrogen Content		M.I. Search Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.19 %	Maximum	Mins.	Maximum	Mins.
Minimum	13.12 %	Minimum	Mins.	Minimum	Mins.
Average	13.14 %	Average	45+ Mins.	Average	30 Mins.
				Explosion	Mins.

MANUFACTURE OF PROPELLANT

Total weight of solvent per pound NC 55-65 lb Consisting of 36 pounds alcohol and 64 pounds ether per 100 pound solvent. Percentage of remix to whole

TEMPS., °C. From	TEMPS., °C. To	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES Days	TIMES Hours
40	60	Solvent Recovery	1	20
	65	Water Dry	4+	
	55	Air Dry		7-9
		This lot of powder processed without macaroni press.		

TESTS OF FINISHED PROPELLANT

COMPOSITION

Constituent	Formula	Mfr.	Inspr.
Nitrocellulose	87.0	±2.0	86.4
DNT + DBP	13.0		13.6
DNT	10.0	±2.0	10.3
DBP	3.00	±1.00	3.34
DPA (Added)	1.00	±0.10	1.05
volatile Solvents	1.35	max.	1.04
Moisture	0.60	±0.20	0.48
Ash	0.40	max.	----

STABILITY AND PHYSICAL TESTS

	Mfr.	Inspr
135° C heat test, S.P.		50 min.
Explosion		5+ hrs.
Form of grain	Cyl	
No. of perforations	7	
No. of grains per pound		
Burning surface per pound (sq. inches)		
Grav. density, or pounds per cu. ft.		
Specific gravity		
Hygroscopicity		
Compression test (Per Cent)		44.

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Inspector
Length (L)	cut .508		0.4792		1.4
Diameter (D)	.2y4		0.2054		1.3
Diameter of perforations (d)	.028		0.0179		
Web Inner	.0535		0.0373		
Web Outer	.0515		0.0385		
Web Average	.0525		0.0379		
Web Calculated					
Difference between inner and outer web in per cent of web average			3.		
L:D (Y)			2.33		
D:d (X)			12.		

Date packed 3-2-55 Date offered 3-2-55 Date sampled 3-2-55

Date test finished 3-11-55 Date description sheets forwarded 3-29-55

Type of Packing Box Galv. Steel Containers - Mk.VII and Mk

Remarks: Samples withdrawn - 88 lbs.; Available for shipment - 450,010 lbs. This lot meets physical and chemical requirements.

Technical Director	Inspector of Ordnance (Acting)	U.S. Chemist
[illegible]	H. L. Jacobsen	David B. Johnson
	L. Jacobsen	D. B. Johnson

OD FORM 1205
15 Apr. 52

ORDNANCE CORPS
PROPELLANT DESCRIPTION SHEET

Supersedes OO Form 1204 dated 1 Jul. 49 which is obsolete.

U.S. Army Lot No. IA-39734 of 1956 Composition No. M6 For 155 mm Gun. M2 Chg, M19

Manufactured at: Indiana Arsenal, I.O.W., Charlestown, Indiana Packed Weight 451,980 lbs.

Contract No. DA-11-173 Date Jan. 3, 1952 Specification No. JAN-P-309 Revision of ORD-154

NITROCELLULOSE Wood pulp

Accepted Blends (Nos.) I.O.W.-E-2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.17 %	Maximum	45 + Mins.	Maximum	35 Mins.
Minimum	13.14 %	Minimum	45 + Mins.	Minimum	35 Mins.
Average	13.16 %	Average	45 + Mins.	Average	35 Mins.
				Explosion	Mins.

MANUFACTURE OF PROPELLANT

Total weight of solvent per pound NC 0.76 Consisting of 32 pounds alcohol and 68 pounds ether per 100 pound solvent. Percentage of remix to whole Not more than 2% per mixer.

Temps. °C. From	Temps. °C. To	PROCESS—SOLVENT RECOVERY AND DRYING	Time Days	Time Hours
35	60	Solvent recovery - raise 5°C per hour		
		hold for 91 hours at 60°C		96
65	65	Water dry		156
55	55	Air dry		16

TESTS OF FINISHED PROPELLANT

COMPOSITION

Constituent	Formula	Mfr.	Inspr.
Nitrocellulose	87.00	86.53	
Dinitrotoluene	10.00	10.45	
Dibutylphthalate	3.00	3.02	
Diphenylamine (added)	1.08	1.02	
Total Volatile Solvents		1.52	
Moisture, Distillation		0.65	
Ash		0.10	

STABILITY AND PHYSICAL TESTS

	Mfr.	Inspr.
135° C heat test, S. P.	50 min.	
Explosion	5 + hrs.	
Form of grain	Cylindrical	
No. of perforations	7	
No. of grains per pound	316	
Burning surface per pound (sq. inches)		
Grav. density, or pounds per cu. ft.		
Specific gravity		
Hygroscopicity		
Compression test	32.3	

GRAIN DIMENSIONS	DIE (INCHES)	Finished Grain (Inches) Manufacturer	Finished Grain (Inches) Inspector	Mean Variation in Per Cent of Mean Dimension Manufacturer	Mean Variation in Per Cent of Mean Dimension Inspector
Length (L)	0.780	0.7545		0.6	
Diameter (D)	0.450	0.3265		1.3	
Diameter of perforations (d)	0.044	0.0326			
Web Inner		0.0563			
Web Outer		0.0581			
Web Average		0.0572			
Web Calculated					
Difference between inner and outer web in per cent of web average		3.1			
L:D (Y)		2.31			
D:d (X)		10.0			

Date packed Sept. 13, 1956 Date offered Sept. 20, 1956 Date sampled 14 September 1956

Date test finished Sept. 20, 1956 Date description sheets forwarded 27 September 1956

Type of Packing Box Drums, Metal (Reconditioned) Dwg. No. 76-1-1039

Remarks: This lot meets chemical and physical requirements.

C. R. THOMBS, MANAGER

Superintendent	Inspector of Ordnance	U. S. Chemist
D.C. Fullington, Tech. Supt.	Deputy Army W. W. STRUCK	

Ordnance Corps

Propellant Description Sheet

Lot: IA-R-R 39744 Propellant M6 (M.P.) for 155 mm Gun M2 Chg. 209

Reblended at: Indiana Arsenal, I.O.M., Charlestown, Indiana. Packed Wt. 453,870 lbs

Contract No. DA-11-173- Date Jan. 3, 1952 Specification JAN-P-309

ORD-156

This lot consists of a blend of propellant powder of composition M6 (M.P.) for 155 mm Gun, M2 Chg. 209 recovered from debagged charges.

The lot numbers used in the blend are tabulated on the reverse side.

Constituent	Formula	Mfr.	Insp.
Available Stabilizer		0.77	
Total Solvents		1.12	
Moisture Distillation		0.55	
Ash			

Stability and Physical Tests	Mfr.	Insp.
134.5° C heat test, s.v.	45 min.	
Explosion	5 + hrs.	
Form of grain	Cylindrical	
No. of perforations	7	
No. of grains per pound	350	

Grain Dimensions	Die	Finished Grain Manufacturer	Finished Grain Inspector	Mean Variation Manufacturer	Mean Variation Inspector
Length (L)		0.7588		0.7	
Diameter (D)		0.3184		1.9	
Diameter of perforations (d)		0.0232			
Web Inner		0.0576			
Web Outer		0.0578			
Web Average		0.0577			
Web Calculated					
Web average		0.3			
		2.38			
D/d		10.9			

Remarks: This lot meets available DPA content as specified in ltr. OAC-ORDIX-M-P dated 18 Nov. 1955, Subj: Mfg. Requirements for Reblended M1 and M6 Prop. and moisture and total volatile requirements of JAN-P-309. Other data for information purposes.

Date packed August 21, 1956 Date offered August 24, 1956 Date sampled 22 Aug 1956

Date test finished August 24, 1956 Date description sheets forwarded 10 Sept 1956

Type of Packing Box Drums, metal (reconditioned) Dwg. No. 76-1-1039

Remarks: Local acceptance of this lot is made for authorizing payment of fixed fee for reblending

R. TROMBS, MANAGER

D.C. Fullington, Tech. Supt. R. W. STRUCK Inspector of Ordnance, U.S. Army

Lot Number	MP (Min.)	% Available Stabilizer	Approx. Wt. (lb
RAD 19595	55	.82	48,195
ALA 33302	50	.68	30,356
ALA 33304	50	.82	102,172
ALA 33307	45	.98	89,532
ALA 33311	40	.96	9,507
ALA 33314	50	.82	32,844
ALA 33385	40	.84	143,329
		Approximate weight before reblending	450,935

OO FORM 1204
18 Apr. 52

ORDNANCE CORPS
PROPELLANT DESCRIPTION SHEET

Supersedes CO Form 1204 dated 1 Jul. 49 which is obsolete.

U.S. Army Lot No. RAD-RB-64012 of 1956 Composition No. M6 For 155 M/M CHG, M2 W/CHG. M19

Manufactured at: RADFORD ARSENAL, RADFORD, VIRGINIA Packed Weight 450,900

Contract No. W-11-173- Date 4-28-49 Specification No. ____ Revision of ____
ORD-37

NITROCELLULOSE

Accepted blends (Nos.) ____

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	%	Maximum	Mins.	Maximum	Mins.
Minimum	%	Minimum	Mins.	Minimum	Mins.
Average	%	Average	Mins.	Average	Mins.
				Explosion	Mins.

MANUFACTURE OF PROPELLANT

Total weight of solvent per pound NC ____ Consisting of ____ pounds alcohol and ____ pounds ether per 100 pound solvent. Percentage of remix to whole ____

Temps. °C. From	Temps. °C. To	PROCESS—SOLVENT RECOVERY AND DRYING	Times Days	Times Hours
		*All sublots of this lot meet the available DPA requirements of RAPD 4000, dated 27 March 1956, and this lot meets the volatile solvents (RS) and moisture requirements of JAN-P-309. Other data for informational purposes.		

TESTS OF FINISHED PROPELLANT

COMPOSITION Constituent	Formula	Mfr.	Mfr.
Available Diphenylamine			0.53
Total volatiles			1.82
Moisture	0.60 ± .20		0.68
Residual Solvent	1.50 max		1.14

STABILITY AND PHYSICAL TESTS	Mfr.	Insp.
135° C heat test, S. P.		
Explosion		
Form of grain	cyld	
No. of perforations	7	
No. of grains per pound		
Burning surface per pound (sq. inches)		
Grav. density, or pounds per cu. ft.		
Specific gravity		
Hygroscopicity		
Compression test	39.35	

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Inspector
Length (L)		0.7399		2.29	
Diameter (D)		0.3206		1.99	
Diameter of perforations (d)		0.0334			
Web Inner		0.0545			
Web Outer		0.0558			
Web Average		0.0552			
Web Calculated					
Difference between inner and outer web in per cent of web average		2.36			
L:D (X)		2.31			
D:d (X)		9.60			

Date packed 8/2/56 Date offered 8-17-56 Date sampled 8-3-56

Date test finished 8-8-56 Date description sheets forwarded AUG [illegible]

Type of Packing Box Metal Drums

Remarks: *

Assistant Technical Superintendent — R. C. Rhodes

Army — W. Patteson

H. Moncure

Original lot numbers and approximate weights of lots used in FR-64012:

Lot Number	Approximate Number Of Pounds	Available DPA
33749	46,800	0.72
33744	100,000	0.57
33715	41,900	0.56
33748	61,200	0.55
33745	71,400	0.58
33742	30,600	0.60
33738	99,000	0.61
	450,900	

- 9 ƒ !3

CO FORM 1204 15 Apr. 53	ORDNANCE CORPS PROPELLANT DESCRIPTION SHEET	Supersedes [illegible] dated [illegible] is obsolete.

U.S. Army Lot No. PA-E-R-21406 of 1956 Composition No. M6 (rework) For 155mm Gun, M2, for Charge, propelling, M19

Manufactured at: Picatinny Arsenal, Dover, N. J. Packed Weight 2,690 lbs
PRSD 60304111-19-45061-01-0-311 Specification No. JAN-P-309 Revision of 28 March 1946

NITROCELLULOSE

Accepted blends (Nos.) Rework - Lots - ALA - 33701, 33702, 33733, 33708, 33709, 33722

Nitrogen Content	K. I. Starch Test (65.5° C.)	Stability Test (135° C.)
Maximum ____ %	Maximum ____ Mins.	Maximum ____ Mins.
Minimum ____ %	Minimum ____ Mins.	Minimum ____ Mins.
Average ____ %	Average ____ Mins.	Average ____ Mins.
		Explosion ____ Mins.

MANUFACTURE OF PROPELLANT

Total weight of solvent per pound ingredient 0.69 Consisting of 33 pounds alcohol and 67 pounds ether per 100 pound solvent. Percentage of rework to whole none.

TEMPS. °C From	To	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES Days	Hours
		DuPont Type Car Solvent Recovery		
	30	Temperature held while loading car		8
30	65	Solvent recovery raised 2°C per hour		17½
	65	Held at constant temperature		42½
	65	Dry House - Water Dry - Constant Temperature	8	
	55	Dry House - Air Dry - Constant Temperature		14

TESTS OF FINISHED PROPELLANT

COMPOSITION %

Constituent %	Formula	Mfr.	Inspr.
Nitrocellulose	87.0 ± 2.0		86.36
Dinitrotoluene	10.0 ± 2.0		10.40
Dibutylphthalate	3.00 ± 1.00		3.24
Diphenylamine (added)	1.00 ± 0.10		1.19
Total volatiles			2.27
Moisture Total	0.60 ± 0.20		0.58
Ash	0.40 max.		0.17
Volatile solvents	1.70 max.		1.69

STABILITY AND PHYSICAL TESTS

134.5°C	Mfr.	Inspr.
134.5° C heat test, S. P.		35[illegible]
Explosion in 5 hrs		none
Form of grain		cyl'd.
No. of perforations		7
No. of grains per pound		315
Burning surface per pound (sq. inches)		
Grav. density, or pounds per cu. ft.		51
Specific gravity		
Hygroscopicity		
Compression test %		47.7

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Inspector
Length (L)	0.7805		0.7400		1.38
Diameter (D)	0.4450		0.3273		1.59
Diameter of perforations (d)	0.0430		0.0313		
Web Inner	0.0840		0.0574		
Web Outer	0.0740		0.0597		
Web Average	0.0790		0.0586		
Web Calculated	0.0790		0.0585		
Difference between inner and outer web in per cent of web average	15 max		3.92		
L:D (X)	2.10 to 2.50		2.26		
D:d (X)	5 to 15		10.45		

Date packed 8-24-56 Date offered 8-24-56 Date sampled 8-24-56
Date test finished 10-17-56 Date description sheets forwarded [illegible]
Type of Packing Box Steel Mk7, Navy, for Smokeless Powder, 110 lb. capacity
[illegible] Dwg. 138439, Rev. 7 May 1939 See Reverse side
This lot of propellant is for experimental purposes

[signature]	Inspector of Ordnance [signature]	U. S. Chemist
W. L. PARTRIDGE, Ch. P&E Br	R.J.KELLY, Deputy Ch Insp Div	

Lot PA-E-R-21406 of 1956

Acidity (as HNO_3), %	0.08

100°C Taliani Test:

Slope at 100mm	1.22
Minutes to 100mm	37
Slope at 100 minutes	1.20

100°C Vacuum Stability Test:

Ml of gas in 24 hours	11.4

Nitrogen of Nitrocellulose	13.04

Nitro Derivatives:

Available Diphenylamine	1.09
Diphenylamine, %	0.80
N-Nitrosodiphenylamine, %	0.20
2-Nitrodiphenylamine, %	0.09
	1.09

(Type [illegible] for [illegible])

SMOKELESS POWDER DESCRIPTION SHEET

U. S. Army Lot No. 29220 of 1945 Mfr. Lot No. ______ Type ______ For ______ Model of ______
Packed Weight 49,950 lbs. Manufactured at Oklahoma Ordnance Works, Pryor, Oklahoma.

Contract No. W-ORD-521, DA-W-ORD-8 Date 9-11-41 Specification No. 50-12-98 [illegible] 18 May, 1944
As Amended

NITROCELLULOSE

Accepted blends (Nos.) "Linters" 8679, 8682, 8710, 8711, 8712

	Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)
Maximum	13.18	Maximum	44'	Maximum	35'
Minimum	13.15	Minimum	42'	Minimum	30'
Average	13.17	Average	43'	Average	30'
				Explosion	

MANUFACTURE OF POWDER

Total weight of solvent per pound N/C .92 lb. Consisting of 35 pounds alcohol and 65 pounds ether per 100 pound solvent. Percentage of remix to whole 4.17%

Temp. °C. From	Temp. °C. To	Process—Solvent Recovery and Drying	Times Days	Times Hours
35	55	Solvent Recovery (35°C. - 4 hrs., 35°C. to 55°C. - 4 hrs., 55°C. - 16 hrs.)		24
58	58	Water dried before coating		165
58	58	Water dried after coating		48
53	53	Air dried		20

TESTS OF FINISHED POWDER

Composition: Constituent	Formula	Mfr.	Insp.	Stability and Physical Tests	Mfr.	Insp.
Nitrocellulose	100.0	89.20		135° C. heat test, S. P.	55'	55'
Pot. Sulphate added	1.00	0.70		Explosion 5 + hrs.		5 hrs +
Dinitrotoluene		7.81		Form of grain cylindrical		
				No. of perforations	1	
				No. of grains per pound	94,711	
Diphenylamine added	0.62	0.60		Burning surface per pound (sq. inches)	2063	
Total volatiles		1.66		Grav. density, [illegible]	.955	
Moisture		1.08	0.99	Specific gravity		
Ash		0.12		Hygroscopicity		
Graphite coated				[illegible] % Dust	.080	

Grain Dimensions	Die (inches)	Finished Grain (inches) Manufacturer	Finished Grain (inches) Inspector	Mean Variation in Per Cent of Mean Dimension Manufacturer	Mean Variation in Per Cent of Mean Dimension Inspector
Length (L)	.0909	.0826			
Diameter (D)	.0830	.0750			
Diameter of perforation (D)	.0210	.0114			
Web: Inner					
Web: Outer					
Web: Average	.0310	.0218			
Web: Calculated					
Difference between inner and outer web in per cent of web average					

[illegible] Unglazed .006%; Double Length .000%; Short Cuts .006%; Foreign Grains .006%; [illegible] Tailings .000%.

Date packed 5-12-45 Date offered 5-14-45 Date sampled 5-14-45
Date test finished 5-18-45 Date description sheet forwarded 5-24-45

Remarks: Packed in Plywood Stainless Steel lined boxes, O.O. Drawings 76-4-56; 76-4-56A; 76-4-57, 76-4-58. This lot meets chemical and physical requirements. alh

R.J.Quaid Technical Superintendent.
Army Inspector of Ordnance.
Edison Powers, 2d Lt O D

U. S. Ordnance [illegible]

SMOKELESS POWDER DESCRIPTION S

U. S. Army Lot No. 20221 of 1945 Mfr. Lot No. ____ Type ____ For ____ Model of ____

Packed Weight 49,950 lbs. Manufactured at Oklahoma Ordnance Works, Pryor, Oklahoma.

Contract No. W-ORD-521, DA-W-ORD-8 Date 9-11-41 As Amended Specification No. 50-12-98 ____ 18 Nov. 1944

NITROCELLULOSE

Accepted blends (Nos.) "Linters" 8703, 8704, 8706, 8712, 8713.

	Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)
Maximum	13.18	Maximum	45'	Maximum	30'
Minimum	13.15	Minimum	40'	Minimum	30'
Average	13.17	Average	43'	Average	30'
				Explosion	

MANUFACTURE OF POWDER

Total weight of solvent per pound N/C .92 lb. Consisting of 35 pounds alcohol and 65 pounds ether per 100 pound solvent. Percentage of remix to whole 6.39

Temps. °C. From	Temps. °C. To	Process—Solvent Recovery and Drying	Times Days	Times Hours
35	58	Solvent Recovery (35°C. - 4 hrs., 35°C. to 55°C. - 4 hrs., 55°C. - 16 hrs.)		24
58	58	Water dried before coating		168
58	58	Water dried after coating		48
55	55	Air dried		9

TESTS OF FINISHED POWDER

Constituent	Formula	Mfr.	Inspr.
Nitrocellulose	100.0	89.24	
Pot. Sulphate added	1.00	0.76	
Dinitrotoluene		7.72	
Diphenylamine added	0.62	0.61	
Total volatiles		1.68	
Moisture		1.08	1.00
Ash			
Graphite coated			

Stability and Physical Tests	Mfr.	Inspr.
135° C. heat test, S. P.	50'	50'
Explosion 5 + hrs.		5 hrs +
Form of grain cylindrical		
No. of perforations	1	
No. of grains per pound		
Burning surface per pound (sq. inches)		
Grav. density,	.953	
Specific gravity		
Hygroscopicity		
Compression test		

Grain Dimensions	Die (Inches)	Finished Grain (Inches) Manufacturer	Finished Grain (Inches) Inspector	Mean Variation in Per Cent of Mean Dimension Manufacturer	Mean Variation in Per Cent of Mean Dimension Inspector
Length (L)	.0909	.0824			
Diameter (D)	.0830	.0547			
Diameter of perforations (D)	.0210	.0110			
Web Inner					
Web Outer					
Web Average	.0310	.0219			
Web Calculated					
Difference between inner and outer web in per cent of web average					
L:D (Y)					
D:d (X)					

Date packed 5-12-45 Date offered 5-14-45 Date sampled 5-14-45

Date test finished 5-18-45 Date description sheets forwarded 5-24-45

Remarks: Packed in Plywood Stainless Steel lined boxes, O.O. Drawings 76-4-56, 76-4-55, 76-4-57, 76-4-58. This lot meets chemical and physical requirements. mlh

E.J.Quaid Technical Superintendent

/s/ Army Inspector of Ordnance
/t/ Edison Powers, 2d Lt O D

U. S. Chemist

SMOKELESS POWDER DESCRIPTION

U. S. Army Lot No. 29250 of 1945 Mfr. Lot No. ______ Type ______ For ______, Model of ______

Packed Weight 19,950 lbs. Manufactured at Oklahoma Ordnance Works, Pryor, Oklahoma.

Contract No. W-ORD-521, DA-W-ORD-8 Date 9-11-41 Specification No. 50-12-28 Revision 4 18 Mar. 1944
As Amended

NITROCELLULOSE

Assigned blends (Nos.) "Linters" 8733, 8744, 8747, 8748, 8749, 8752, 8754.

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.17	Maximum	45'	Maximum	30'
Minimum	13.11	Minimum	39'	Minimum	30'
Average	13.14	Average	41'	Average	30'
				Explosion	

MANUFACTURE OF POWDER

Total weight of solvent per pound N/C .94 lb. Consisting of 35 pounds alcohol and 65 pounds ether per 100 pound solvent. Percentage of solvent to whole 5.36

TEMPS. °C. From	TEMPS. °C. To	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES Days	TIMES Hours
35	55	Solvent Recovery (35°C. to 55°C. - 3 hrs., 55°C. - 25 hrs.)		28
58	58	Water dried before coating		156
58	58	Water dried after coating		19
53	53	Air dried		11

TESTS OF FINISHED POWDER

COMPOSITION: Constituent	Formula	Mfr.	Inspr.	STABILITY AND PHYSICAL TESTS	Mfr.	Inspr.
Nitrocellulose	100.0	89.73		135° C. heat test, S. P.	50'	55'
Pot. Sulphate added	1.00	0.77		Explosion 5 + hrs.		5 hrs +
Dinitrotoluene		7.15		Form of grain cylindrical		
				No. of perforations	1	
				No. of grains per pound		
Diphenylamine added	0.62	0.58		Burning surface per pound (sq. inches)		
Total volatiles		1.77		Grav. density	950	
Moisture		1.04	1.06	Specific gravity		
Ash				Hygroscopicity		
Graphite coated				% Dust	.009	

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Inspector
Length (L)	.0909	.0832			
Diameter (D)	.0830	.0551			
Diameter of perforations (d)	.0210	.0113			
Web Inner					
Web Outer					
Web Average	.0310	.0219			
Web Calculated					
Difference between inner and outer web in per cent of web average					
L:D (Y)					
D:d (X)					

Date packed 5-25-45 Date offered 5-28-45 Date sampled 5-28-45

Date test finished 5-31-45 Date description sheet forwarded 6-5-45

Remarks: Packed in Plywood Stainless Steel-lined boxes, O.O. Drawings 76-4-59; 76-4-59A; 76-4-60; 76-4-61. This lot meets chemical and physical requirements. 2,500 lbs. of the powder included in this lot has been exposed to 65° temperature in Water Dry treatment for 1½ hrs.

R. J. Quaid [signature]
Technical Superintendent.

ejl

for [signature] R. E. ...
Army Inspector of Ordnance.
Edison Powers, 2d Lt O

mlh
U. S. Chemist

CO FORM 19 Apr. 62 1204	ORDNANCE CORPS PROPELLANT DESCRIPTION SHEET	Supersedes OO Form 1204 dated 1 Jul. 49 which is obsolete.

U.S. Army Lot No. 60326 of 1954 Composition No. 62 For 90 M/M
Com M/CANISTER T22E1
Manufactured at: Radford Arsenal, Radford, Va. Packed Weight 150.255
Contract No. W-11-173 Date 6-22-49 Specification No. JAN-P-323 Revision of w/amendment 1
CAD-37 NITROCELLULOSE dated 29 July 1952
Accepted blends (Nos.) C 13,448-564-574-590-611-613-617-618-619-642-650-660

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.17 %	Maximum	45 + Mins.	Maximum	30 Mins.
Minimum	13.12 %	Minimum	45 + Mins.	Minimum	30 Mins.
Average	13.14 %	Average	45 + Mins.	Average	30 Mins.
				Explosion	Mins.

MANUFACTURE OF PROPELLANT

dry ingredient
Total weight of solvent per pound NC 35.5 Consisting of 44 pounds alcohol and 56 pounds acetone per 100 pound solvent. Percentage of remix to whole 10%

TEMP., °F. From	TEMP., °F. To	PROCESS—SOLVENT RECOVERY AND DRYING	Hours	From	To	TIMES Days	TIMES Hours
21		Forced Air Dry	22	55	60		5
21	40	Forced Air Dry	5	60	60		229
40	40	Forced Air Dry	19				
40	55	Forced Air Dry	5				
55	55	Forced Air Dry	43				

TESTS OF FINISHED PROPELLANT

COMPOSITION Constituent	Formula	Spec. Min. Max.	Mfr.	STABILITY AND PHYSICAL TESTS	Mfr.	Inspr.
Nitrocellulose	77.65	± 2.0	77.38	120° C heat test, S. P.	60'	
Nitroglycerin	19.50	± 1.0	19.68	Explosion	60'	
Barium Nitrate	1.40	± .20	1.30	Form of grain	cyld	
Potassium Nitrate	0.75	± .25	0.85	No. of perforations	7	
Graphite	0.30	± .10	0.26	No. of grains per pound		
Ethyl Centralite	0.60	± .15	0.53	Burning surface per pound (sq. inches)		
Total volatiles	3.10	max.	2.90	Grav. density, or pounds per cu. ft.		
Moisture	0.70	max.	0.22	Specific gravity		
Ash	0.40	max.	0.05	Hygroscopicity		
Residual Solvent	3.12	max.	2.68	Compression test	49.88	

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Inspector
Length (L)	1.340 ± .02	1.3349		0.71	
Diameter (D)	0.703	0.5780		1.35	
Diameter of perforations (d)	0.081	0.0691			
Web: Inner	0.1150	0.0913			
Web: Outer	0.1150	0.0940			
Web: Average	0.1150	0.0927			
Web: Calculated					
Difference between inner and outer web in per cent of web average		2.91			
L:D (Y)		2.31			
D:d (X)		8.36			

Date packed 12/16/54 Date offered 5 January 1955 Date sampled 12-17-54
Date test finished 12-31-54 Date description sheets forwarded
Type of Packing Box St. Steel
Remarks: This lot meets chemical and physical requirements
Assistant Technical Army

Superintendent	Inspector of Ordnance	U. S. Chemist
H.R.Davies for	M.C.Willard	James W. Patterson

BP

U.S. Army Lot No. 39649 of 1953 Composition No. M-9 For 81 mm. Mortar Ignition Cartridge M3 A1 M3

Manufactured at: Hercules Powder Company, Kenvil, N. J. Packed Weight 4260 lbs.

Contract No. DA-30-069-ORD-1542 Date Specification No. PA-PD-55 Revision of

NITROCELLULOSE

Accepted blends (Nos.) 10115-Y

Nitrogen Content	K. I. Starch Test (65.5° C.)	Stability Test (135° C.)
Maximum	Maximum	Maximum
Minimum	Minimum	Minimum
Average 13.25	Average 45'+	Average 30'
		Explosion

MANUFACTURE OF POWDER

Total weight of solvent per pound ingredients .27 Consisting of 48 pounds alcohol and 52 pounds Acetone per 100 pound solvent. Percentage of remix to whole

TEMPS. °C. From	TEMPS. °C. To	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES Days	TIMES Hours
55	60	Air Dry	3	12

TESTS OF FINISHED POWDER

COMPOSITION Constituent	Formula	Mfr.	Inspr.
Nitrocellulose	57.25	58.26	
Nitroglycerin	40.00	39.75	
Potassium Nitrate	2.00	1.24	
Ethyl Centralite	0.75	0.75	
	100.00		
Graphite		0.15	
Total volatiles		0.25	
Moisture			
Ash		0.01	

STABILITY AND PHYSICAL TESTS	Mfr.	Inspr.
120°C heat test, S. P.	45'	
Explosion		
Form of grain	Flake	
No. of perforations	None	
No. of grains per pound		
Burning surface per pound (sq. inches)		
Grav. density, or pounds per cu. ft.		
Specific gravity		
Hygroscopicity		
Compression test		

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PER CENT OF MEAN DIMENSION Inspector
Length (L)	.010	.0064			
Diameter (D)	.070	.0601			
Diameter of perforations (d)					
Web — Inner					
Web — Outer					
Web — Average					
Web — Calculated					
Difference between inner and outer web in per cent of web average					
L:D (Y)					
D:d (X)					

Date packed 5-14-56 Date offered 5-14-56 Date sampled 5-16-56

Date test finished 5-23-56 Date description sheets forwarded 5-24-56

Type of Packing Box Metal 3/4 Drum

Remarks: Analysis witnessed by NYOD Propellant Explosives Chemist

Superintendent L. C. Pritchett L. C. PRITCHETT Inspector of Ordnance U. S. Chemist A. Sternberg A. STERNBERG

3—0054

SMOKELESS POWDER DESCRIPTION SHEET

U. S. Army Lot No. RAD 60310 of 1954 Composition No. M-10 For 106 M/M Rifle T170 W/C S. HE-T, T119E11, M344

Manufactured at: Radford Arsenal; Radford, Virginia Packed Weight 160,710

Contract No. W-11-173-ORD-37 Date 28 April 1949 Specification No. PA-PD-123 Revision of NITROCELLULOSE W/Amendment 3 dated 25 Nov. 1952

Accepted blends (Nos.) B13,969-971-72-973-974-975-976-978-980-981-982-983-984-985-979-987-968-990Y

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135°C.)	
Maximum	13.17	Maximum	45	Maximum	30
Minimum	13.13	Minimum	45	Minimum	30
Average	13.14	Average	45	Average	30
				Explosion	

dry ingredient MANUFACTURE OF POWDER

Total weight of solvent per pound NC 0.90 Consisting of 33 pounds alcohol and 67 pounds ether per 100 pounds solvent. Percentage of remix to whole 10%

TEMP. °C. From	TEMP. °C. To	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES Days	TIMES Hours
	40	Solvent Recovery		Load
40	50	Solvent Recovery		8
50	55	Solvent Recovery		48
65	65	Water Dry	17	
55	55	Air Dry		14-16

TEST OF FINISHED POWDER

COMPOSITION Constituent	Formula	Mfr.	Inspr.	STABILITY AND PHYSICAL TESTS	Mfr.	Inspr.
Nitrocellulose	98.00	98.06		135° C heat test, S. P.	60'	
Diphenylamine	1.00	.94		Explosion	none	
Potassium Sulfate	1.00	1.00		Form of grain	cyld	
Graphite (glaze)	0.10	0.11		No. of perforations	7	
Residual Solvents		2.04		No. of grains per pound		
				Burning surface per pound (sq. inches)		
Total volatiles		3.19		Grav. density, or pounds per cu. ft.		
Moisture		1.15		Specific gravity		
Ash		0.06		Hygroscopicity		
Dust		0.009		Compression test (average %)	40.71	

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN PERCENT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN PERCENT OF MEAN DIMENSION Inspector
Length (L)	0.489	0.4484		1.35	
Diameter (D)	0.294	0.1948		2.21	
Diameter of perforations (d)	0.031	0.0194			
Web Inner	0.054	0.0354			
Web Outer	0.047	0.0331			
Web Average	0.051	0.0343			
Web Calculated					
Difference between inner and outer web in percent of web average		6.71			
L:D (Y)		2.30			
D:d (X)		10.04			

Date packed 13 April 1954 Date offered 27 April 1954 Date sampled 13 April 1954

Date test finished 22 April 1954 Date description sheets forwarded MAY 5 1954

Type of Packing Box M.A. #2

Remarks: This lot meets chemical and physical requirements.

Contractor's Rept.	Army Inspector of Ordnance	Ord. Rept.
W.G. Rue	M.C. Willard	James W. Patteson

15 Apr. 52 | PROPELLANT DESCRIPTION SHEET | dated 1 Jul. 47 which is obsolete.

U.S. Army Lot No. RAD 38145 of 1956 Composition No. T28 For 106 H/M
IEI.E, M40 W/CTG. HEAT, M344
Manufactured at: RADFORD ARSENAL, RADFORD, VIRGINIA Packed Weight 150,260
Contract No. W-11-173- Date 4-20-49 Specification No. PA-PD-329 [illegible] with AIR 23377-S
ORD-37
Accepted blends (Nos.) B 15,016-050-051-055-059-063 NITROCELLULOSE dated 24 August, 1956

Nitrogen Content		K. I. Starch Test (65.5° C.)		Stability Test (135° C.)	
Maximum	13.17 %	Maximum	45 Mins.	Maximum	30 Mins.
Minimum	13.12 %	Minimum	45 Mins.	Minimum	30 Mins.
Average	13.14 %	Average	45 Mins.	Average	30 Mins.
				Explosion	Mins.

MANUFACTURE OF PROPELLANT

Total weight of solvent per pound dry ingredient 0.26 Consisting of 47 pounds alcohol and 53 pounds ether per 100 pound solvent. Percentage of remix to whole 10

TEMPS. °F From	TEMPS. °F To	PROCESS—SOLVENT RECOVERY AND DRYING	TIMES Days	TIMES Hrs.
	95	Forced Air Dry		1
	104	Forced Air Dry		2
	113	Forced Air Dry		2
	122	Forced Air Dry		2
	131	Forced Air Dry		1
	140	Forced Air Dry		42

TESTS OF FINISHED PROPELLANT

COMPOSITION Constituent	Formula	Mfr.	Mfr. Limit	STABILITY AND PHYSICAL TESTS 120	Mfr.	Insp.
Nitrocellulose	67.25	± 1.8	66.85	135° C heat test, S. P.	60'	
Nitroglycerin	25.00	± .75	25.23	Explosion		
Ethyl Centralite	6.00	± .50	6.16	Form of grain	cyl.	
Potassium Nitrate	0.70	± .25	0.80	No. of perforations	7	
Barium Nitrate	0.75	± .20	0.69	No. of grains per pound		
Dust	0.075	max	0.011	Burning surface per pound (sq. inches)		
Total volatiles	2.00	max	0.71	Grav. density, or pounds per cu. ft.		
Moisture	0.70	max	0.27	Specific gravity		
Ash	0.40	max	0.08	Hygroscopicity		
Graphite (less glaze)	0.30	± .10	0.27	Compression test	53.89	
Graphite (glaze)	0.20	max	0.10			

GRAIN DIMENSIONS	DIE (INCHES)	FINISHED GRAIN (INCHES) Manufacturer	FINISHED GRAIN (INCHES) Inspector	MEAN VARIATION IN AND OUT OF MEAN DIMENSION Manufacturer	MEAN VARIATION IN AND OUT OF MEAN DIMENSION Inspector
Length (L)	.515 ± .005	0.5151		0.93	
Diameter (D)	0.266	0.2230		1.21	
Diameter of perforations (d)	0.026	0.0225			
Web Inner	0.0475	0.0396			
Web Outer	0.0465	0.0382			
Web Average	0.0470	0.0389			
Web Calculated					
Difference between inner and outer web in per cent of web average		3.60			
L:D (Y)		2.31			
D:d (X)		9.91			

Date packed 7/13/56 Date offered 8-16-56 Date sampled 7-16-56
Date test finished 7-27-56 Date description sheets forwarded
Type of Packing Box M2
Remarks: This lot meets chemical and physical requirements.

Assistant Technical Superintendent: R. C. Rhodes R C Rhodes
Army Inspector in Charge: J. W. Pattoson J W Pattoson
H. Lieneure H Lieneure

DISTRIBUTION LIST

	Copy No.
Commanding General U. S. Army Materiel Command ATTN: AMCRD-RC - Mr. J. Crellin AMCRD-RC - Mr. J. Chalmers Washington, D. C. 20315	 1 2
Commanding General U. S. Army Munitions Command ATTN: AMSMU-RE-R, Dr. J. Erway AMSMU-RE-R, Dr. E. O'Brien Dover, New Jersey 07801	 3 4
Commanding General U. S. Army Missile Command ATTN: AMSMI-RKK - Dr. D. Sayles AMSMI-RKX - Mr. F. James Redstone Arsenal, Alabama 35808	 5-6 7
Commanding General U. S. Army Missile Command Redstone Scientific Information Center ATTN: Chief, Document Section Redstone Arsenal, Alabama 35808	 8-10
Commanding Officer U. S. Army Ammunition Procurement & Supply Agency ATTN: SMUAP-AREL Joliet, Illinois 60436	 11
Commanding Officer U. S. Army Ballistic Research Laboratories ATTN: AMXBR-BRL-1 Aberdeen, Maryland 21005	 12-13
Commanding Officer Frankford Arsenal ATTN: SMUFA-Propellants & Explosives Section, 1331 Philadelphia, Pennsylvania 19137	 14

	Copy No.
Commanding Officer Picatinny Arsenal ATTN: Technical Information Section Dover, New Jersey 07801	15-20
Commanding General White Sands Missile Range ATTN: Technical Library New Mexico 88002	21-23
Commanding Officer Harry Diamond Laboratories ATTN: Library Connecticut Ave. & VanNess St., N.W. Washington, D. C. 20438	24
Commanding Officer U. S. Army Research Office (Durham) Box CM, Duke Station Durham, North Carolina 27706	25
Army Research Office (CRD-F) Arlington Hall Station Arlington, Virginia	26
Bureau of Naval Weapons ATTN: RMMP-2 RMMP-331 Department of the Navy Washington, D. C. 20360	27 28
Commander U. S. Naval Air Missile Test Center ATTN: Technical Library Point Mugu, California	29-30
Commanding Officer U. S. Naval Propellant Plant ATTN: Research & Development Dept. Indian Head, Maryland 20640	31-32
Commander U. S. Naval Weapons Laboratory ATTN: Technical Library Dahlgren, Virginia 22448	33

	Copy No.
Commander U. S. Naval Ordnance Laboratory ATTN: Library White Oak Silver Spring, Maryland 20910	34
Commander U. S. Naval Ordnance Test Station ATTN: Technical Library Branch China Lake, California 93557	35-37
Commanding Officer Office of Naval Research 1030 E. Green Street Pasadena, California 91101	38
Director Special Projects Office Department of the Navy Washington, D. C. 20360	39
Bureau of Naval Weapons Department of the Navy Washington, D. C. 20360	40
Commander Air Force Flight Test Center ATTN: FTRS Edwards Air Force Base, California	41
Commander APGC (PGBAP-1) Eglin Air Force Base Florida 32542	42
Defense Documentation Center Cameron Station Alexandria, Virginia 22314	43-62
Chemical Propulsion Information Agency The Johns Hopkins University Applied Physics Laboratory 8621 Georgia Avenue Silver Spring, Maryland 20910	63-65

	Copy No.
Scientific and Technical Information Facility ATTN: NASA Representative (S-AK/DL) P. O. Box 5700 Bethesda, Maryland 20014	66-72
Thiokol Chemical Corporation Redstone Division Huntsville, Alabama 35808	73
Rohm & Haas Company Redstone Arsenal Research Division ATTN: Librarian Huntsville, Alabama 35808	74
British Defense Staff British Embassy ATTN: Scientific Information Officer 3100 Massachusetts Avenue Washington, D. C. 20008	75-79
Defense Research Member Canadian Joint Staff (W) 2450 Massachusetts Ave. Washington, D. C. 20008	80-83

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
Picatinny Arsenal
Dover, New Jersey

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b GROUP

3. REPORT TITLE

LONG RANGE STUDY OF PREDICTION OF SAFE LIFE OF PROPELLANTS

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(Last name, first name, initial)*
Garman, Norris, S.
Murphy, James, M.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
April 1965	92	6

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
AMCMS 4810.16.2153.12	
b. PROJECT NO.	Technical Memorandum 1609
c.	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10. AVAILABILITY/LIMITATION NOTICES

Qualified requesters may obtain copies of this report from DDC

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

A long range storage program on many of the standard modern propellant formulations is being conducted at Picatinny Arsenal. Propellant samples are conditioned at temperate, tropical, desert, and laboratory controlled accelerated conditions. Standard and experimental testing techniques are employed to determine the safe life potential of each study propellant, and in turn the test methods are being evaluated as to their applicability for establishing stability potential. It has been shown that stabilizer analysis is an effective means for determining the chemical stability of propellants, however, an analytical problem does exist with ethyl centralite. The 65.5°C. Surveillance Test and Propellant Quick Test both appear to be suitable surveillance tools, however, both have short comings. The Methyl Violet Heat Test has limited value for estimating stability potential of an aged propellant, and the Vacuum Stability and Taliani Tests to date have not proven to be particularly beneficial. The Viscosity Test results continue to show promise and appear to correlate well with the other more reliable testing techniques. A better comprehension of propellant safe life concepts is being realized through the study of the test results of each propellant formulation under study.

DD FORM 1 JAN 64 1473

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Storage						
Propellant						
Conditioned						
Temperate						
Tropical						
Desert						
Accelerated						
Safe Life						
Stability Potential						
Stabilizer						
Chemical Stability						
Surveillance						
Propellant Quick Test						
Methyl Violet Heat Test						
Vacuum Stability Test						
Taliani Test						
Viscosity Test						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year, or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through _____."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through _____."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through _____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS), (S), (C), or (U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.